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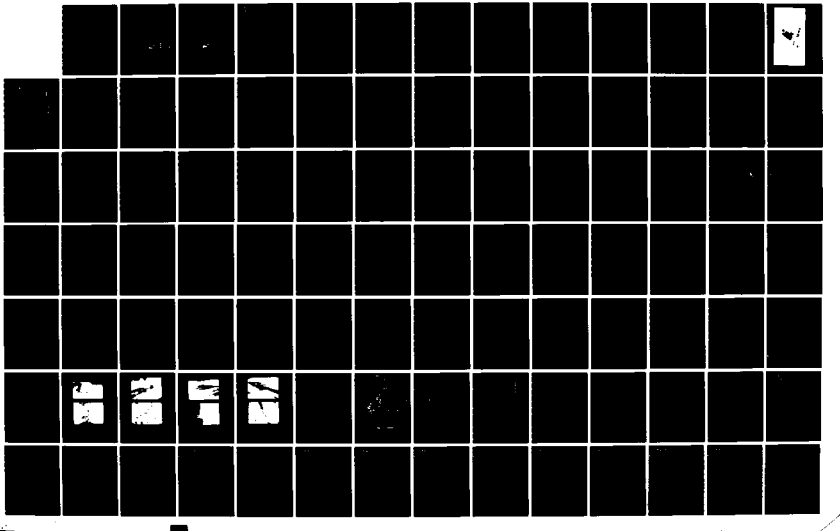

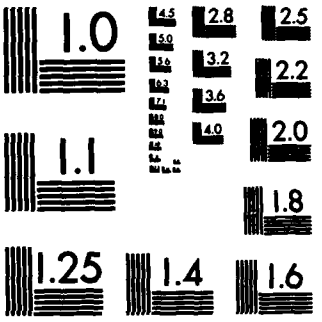

CONNECTICUT COASTAL RIVER BASIN
KILLINGWORTH, CONNECTICUT

KILLINGWORTH RESERVOIR DAM
CT 00401

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MARCH 1979

CONNECTICUT COASTAL RIVER BASIN
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WALTHAM, MASS. 02154

MARCH 1979

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

JUL 03 1979

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

I am forwarding to you a copy of the Killingworth Reservor Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, Connecticut Water Company, West Main Street, Clinton, Connecticut 06413, ATTN: Mr. Kenneth W. Kells.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely yours,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER CT 00401	2. GOVT ACCESSION NO. AD-A144668	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Killingworth Reservoir Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Connecticut Coastal River Basin
Killingworth, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The 560 foot long dam is an earth embankment with a masonry and concrete corewall. The top of the dam is 10 feet wide and, at elevation 299, is roughly 29 feet above the streambed of an unnamed tributary to the Menunketesuck River. Based upon the visual inspection at the site and its past performance, the dam appears to be in good condition. Based upon the size (Intermediate) and hazard classification (High) of the dam in accordance with Corps of Engineers Guidelines, the test flood will be equivalent to the PMF.

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BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name of Dam:	KILLINGWORTH RESERVOIR DAM
Inventory Number:	CT 00401
State Located:	CONNECTICUT
County Located:	MIDDLESEX
Town Located:	KILLINGWORTH
Stream:	TRIBUTARY TO MENUNKETESUCK RIVER
Owner:	CONNECTICUT WATER COMPANY
Date of Inspection:	DECEMBER 19, 1978

Inspection Team:

Peter Heynen (Cahn Engineers, Inc.)
Calvin Goldsmith (Cahn Engineers, Inc.)
Gonzalo Castro (Geotechnical Engineers, Inc.)
Charles Osgood (Geotechnical Engineers, Inc.)
Ken Kells (Connecticut Water Company)
Fred Bloom (Connecticut Water Company)
John King (Connecticut Water Company)
John Roberts (Hartford Insurance Group)

The 560 foot long dam is an earth embankment with a masonry and concrete corewall. The top of the dam is 10 feet wide and, at elevation 299, is roughly 29 feet above the streambed of an unnamed tributary to the Menunketesuck River. Upstream and downstream slopes are at two horizontal to one vertical and three horizontal to one vertical inclinations, respectively. A stone filter and underdrain runs along the downstream toe of the dam on both sides of the spillway. The 40 foot wide spillway may be described as a broadcrested concrete weir of trapezoidal cross-section. The concrete spillway wingwalls were extended vertically and horizontally by means of gabions when the downstream slope was flattened in 1973. The channel bottom below the concrete spillway apron is lined with gabions, as are the channel sides. There is a 16 inch diameter low level outlet pipe and a 6 inch diameter low level outlet pipe through the dam from the concrete intake structure to the downstream channel. There is also a 16 inch diameter low level outlet pipe which runs directly from the reservoir through the intake structure and dam to the downstream channel.

Downstream of Killingworth Reservoir is Kelseytown Reservoir and dam, which is immediately upstream of several residential structures in an area possibly slated for further development.

Based upon the visual inspection at the site and its past performance, the dam appears to be in good condition. No evidence of instability was observed in the dam or its appurtences. There are some areas of seepage requiring monitoring.

Based upon the size (Intermediate) and hazard classification (High) of the dam in accordance with Corps of Engineers Guidelines, the test flood will be equivalent to the Probable Maximum Flood (PMF). Peak inflow to the reservoir is 3500 cfs; peak outflow (Test Flood) is 2560 cfs with the dam overtopped 0.9 feet. Based upon our hydraulics computations, the spillway capacity is 920 cubic feet per second (cfs), which is equivalent to 36 percent of the routed Test Flood outflow.

It is recommended that further studies be undertaken to perform a more refined hydraulic/hydrologic study to determine the best way to increase the capability of the spillway to pass a greater percentage of the Test Flood.

The above recommendation is further discussed in Section 7, as are any necessary remedial measures. The recommendation and remedial measures should be instituted by the owner within 2 years of his receipt of this report.

Peter M. Heynen,
Project Manager
Cahn Engineers, Inc.

STATE OF CONNECTICUT
PETER M. HEYNEN
NO. 9618
REGISTERED
PROFESSIONAL ENGINEER

Edgar B. Vinal, Jr., P. E.
Senior Vice President
Cahn Engineers, Inc.

STATE OF CONNECTICUT
EDGAR B. VINAL, JR.
PROFESSIONAL ENGINEER

This Phase I Inspection Report on Killingworth Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

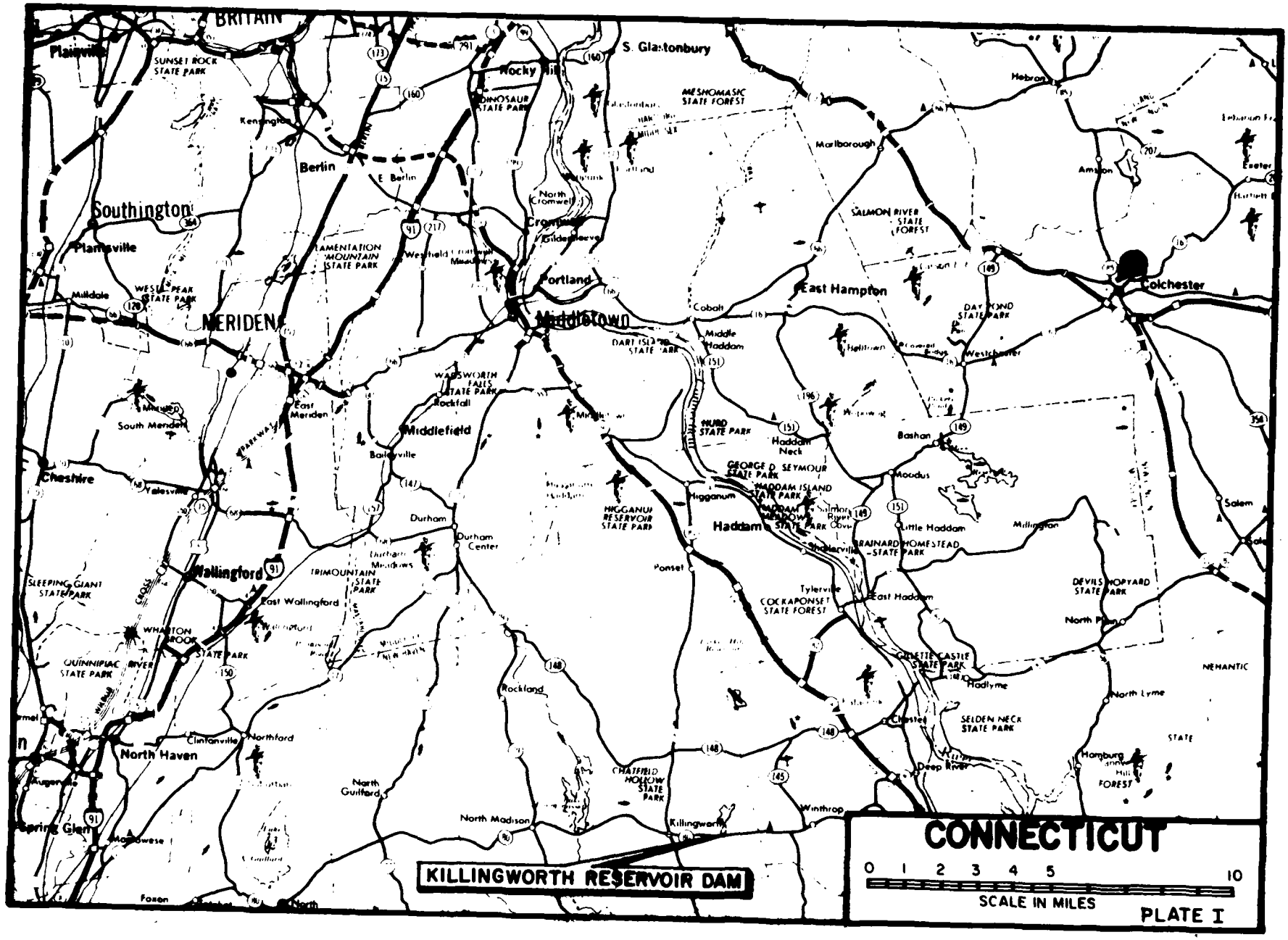
Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

APPENDIX

OVERVIEW PHOTO

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	NATIONAL PROGRAM OF	Killingworth Reservoir Dam	Killingworth	DATE Mar. 1979
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED DAMS	TR-Menunketesuck River	CONNECTICUT	CE # 27595 KA PAGE viii


KILLINGWORTH RESERVOIR DAM
CONNECTICUT
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SCALE IN MILES
PLATE I

PHASE I INSPECTION REPORT

KILLINGWORTH RESERVOIR DAM

SECTION I
PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of November 28, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW 33-79-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

(2) Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.

(3) To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I Inspection Report includes:

(1) Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

(2) A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

(3) Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

(4) An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features on the dam which need corrective action and/or further study.

1.2 Description of Project

a. Location - The dam is located on a tributary to the Menunketesuck River in a rural area of the Town of Killingworth, County of Middlesex, State of Connecticut. The dam is shown on the Clinton Quadrangle having coordinates, latitude N 41° 21.5' and longitude W 72° 32.1'. Killingworth Reservoir Dam is upstream of Kelseytown Reservoir and dam. Kelseytown Reservoir is immediately upstream of 2 low lying residences and an area suited to future development.

b. Description of Dam and Appurtenances The 560 foot long dam is an earth embankment with a masonry and concrete corewall. The top of the dam is 10 feet wide and, at elevation 299, rises approximately 29 feet above the bed of an unnamed tributary to the Menunketesuck River. The upstream slope is inclined to 2 horizontal to 1 vertial and the downstream slope is inclined to 3 horizontal to 1 vertical. The upstream slope is protected by riprap while the downstream slope is grass covered down to where a processed stone blanket and underdrain runs along the toe of the dam. The 40 foot wide spillway may be described as a broadcrested compound weir of trapezoidal cross-section. The concrete spillway wingwalls were extended vertically and horizontally by means of gabions when the downstream slope of the dam was flattened from its original 2 horizontal to 1 vertical slope to its present 3 horizontal to 1 vertical inclination in 1973. The channel bottom below the concrete spillway apron is lined with gabions as are the channel sides. There are three low level cast iron pipe outlets through the dam all of which are operable. One 16 inch low level outlet is at invert elevation 274.4 and the 16 inch outlet directly from the reservoir is at invert elevation 273.3. The 6 inch mud gate outlet is at invert elevation 273.1. All three outlet pipes flow to the spillway discharge channel, two of which are shown in Photo 4.

c. Size Classification - INTERMEDIATE - The dam impounds approximately 1200 acre feet of water with the reservoir level at the top of dam elevation 299. According to the Recommended Guidelines, a dam with storage of between 1000 and 50,000 acre-feet is classified as intermediate in size.

d. Hazard Classification - HIGH - Kelseytown Reservoir, located approximately 9300 feet downstream of Killingworth Reservoir Dam, is also located immediately upstream of 2 low lying residential structures in the initial impact area. A breach outflow from Killingworth Reservoir Dam, routed through Kelseytown Reservoir without failure of Kelseytown Reservoir Dam, would create an 11.5 foot wave at the initial impact area, which would have potential for causing loss of life.

e. Ownership - Connecticut Water Company
West Main Street
Clinton, Connecticut 06413
Mr. Kenneth W. Kells (203) 669-8636

f. Operator - Frederick Bloom
Division Manager
Connecticut Water Company
(203) 669-8636 Ext. 40

g. Purpose of Dam - Public Water Supply

h. Design and Construction History - The following information is believed to be accurate based on the plans and correspondence available. The dam was originally constructed in 1895. As a result of flood damage from the 1938 hurricane, the dam was rebuilt and raised. The original masonry corewall was extended with a concrete wall, new concrete retaining walls for the approach channel to the inlet structure were built and a new spillway was constructed over the original spillway. Also, the earth embankment was raised, the intake structure was raised, and a concrete wall 30 inches high was constructed adjacent to the toe of the masonry core wall to stabilize it where the core wall was undermined during the 1938 flood.

Raising of the Dam - In 1973, to facilitate the raising of the lower portion of the spillway, the downstream slope was flattened to a 3 horizontal to 1 vertical inclination to improve the dam stability, and a toe drain was installed for the length of the dam.

At the present time, further construction is being considered in the form of a larger dam to be located immediately downstream of the present dam.

i. Normal Operational Procedures - The 16 inch low level outlet from the intake structure is operable but is not used. The 16 inch low level outlet directly from the reservoir is used as "the drain valve for the reservoir", and is usually opened from late June until mid October to augment the water supply at Kelseytown Reservoir.

1.3 Pertinent Data

a. Drainage Area -1.5 square miles of rolling, wooded terrain which is sparsely populated.

b. Discharge at Damsite - Discharge from the reservoir is from 2-16 inch pipes and 1-6 inch pipe, as well as over the spillway.

1.	Outlet works (conduit):	16 inch outlet pipe at invert el. 274.4 16 inch outlet pipe at invert el. 273.3 6 inch outlet pipe at invert el. 273.1
2.	Maximum known flood at damsite:	0.9 ft. over spillway (Jan. 1978)
3.	Ungated spillway capacity @ top of dam:	920 cfs @ 299 el.
4.	Gated spillway capacity at normal pool elev:	N/A
5.	Gated spillway capacity at test flood elev:	N/A
6.	Total spillway capacity at test flood elev:	N/A
7.	Total project discharge @ test flood elev:	2560 cfs

c. Elevation (ft. above Mean Sea Level, U.S.G.S. Datum)

1.	Streambed at centerline of dam:	270 (approx.)
2.	Maximum tailwater:	N/A
3.	Upstream portal invert diversion tunnels:	N/A
4.	Recreation pool:	N/A
5.	Full flood control pool:	N/A
6.	Spillway crest:	295.5
7.	Design surcharge (Original Design):	N/A
8.	Top Dam:	299
9.	Test flood design surcharge:	299.9

d. Reservoir

1.	Length of maximum pool:	4000+ ft.
2.	Length of normal pool:	4000 ft.
3.	Length of flood control pool:	N/A

e. Storage (acre-feet)

1.	Recreation pool:	N/A
2.	Flood Control pool:	N/A
3.	Spillway crest pool:	1084
4.	Top of dam pool:	1200 (See Appendix Section D-7)
5.	Test flood pool:	1200+

f. Reservoir Surface (acres)

1.	Top dam:	86+
2.	Test flood pool:	N/A
3.	Flood-control pool:	N/A
4.	Recreation pool:	N/A
5.	Spillway crest:	86

g. Dam

1.	Type:	Earth embankment with concrete corewall
2.	Length:	560 ft.
3.	Height:	29 ft.
4.	Top Width:	10 ft.
5.	Side Slopes:	2H to 1V (Upstream) 3H to 1V (Downstream)
6.	Zoning:	N/A
7.	Impervious Core:	Concrete
8.	Cutoff:	Not Known
9.	Grout curtain:	N/A
10.	Other:	None

h. Diversion and Regulating Tunnel - N/A

1. Type
2. Length
3. Closure
4. Access
5. Regulating Facilities

i. Spillway

1.	Type:	Broadcrested concrete weir
2.	Length of weir:	40 ft.
3.	Crest elevation:	295.5
4.	Gates:	None
5.	U/S Channel:	N/A
6.	D/S Channel:	Lines with gabions
7.	General:	To natural streambed

j. Regulating Outlets

1.	Invert and Size:	16 inch pipe at 274.4 16 inch pipe at 273.3 6 inch pipe at 273.1
2.	Description	Cast iron pipes
3.	Control mechanisms	Valves in Intake Structure
4.	Other:	N/A

SECTION 2: ENGINEERING DATA

2.1 Design

a. Available Data - The available data consists of drawings, correspondence, water level records, and an operations manual by the State of Connecticut, the owner, and Metcalf and Eddy, the design engineers for the 1973 alterations performed on the dam.

b. Design Features - The available data indicates the design features stated previously herein.

c. Design Data - There were no engineering values, assumptions, test results or calculations made available for the original construction of the dam, the 1938 reconstruction, or the 1973 slope alterations.

2.2 Construction

a. Available Data - An as-built drawing is available for the 1938 dam reconstruction. A drawing of the intake structure based upon field measurements is also available. A proposed plan for the 1973 slope alterations was revised to show proper revised contours as amended and proposed during construction (See Section 2.2b). All the above drawings are available from the owner.

b. Construction Considerations - During the course of the 1973 slope alterations, a wet area was discovered near the left downstream toe of the dam. Revised contours were subsequently provided by the engineer and incorporated into the construction of the altered downstream slope. These revisions consisted of installing a berm on the wet area adjacent to the left downstream toe of the dam to at least elevation 295. The filter and underdrain comprising the toe drain were also extended across the filled area to a depth of three feet below the surface. The revised recommendations were presented in a letter dated October 25, 1973 to the Connecticut Water Company from Metcalf and Eddy, Inc., which is included in Appendix Section B of this report.

2.3 Operations

Lake level readings are taken daily in the summer and twice a week in the winter. The spillway capacity has apparently never been exceeded. A formal operations manual has been compiled for this dam complete with emergency procedures in the event of flooding or threatened flooding.

2.4 Evaluation

a. Availability - Existing data was provided by the State and the owner. The owner made operations available for visual inspection.

b. Adequacy - The limited amount of detailed design data available made an in-depth assessment of the dam impossible. The final assessment of this dam is based primarily on visual inspection, performance history, hydraulic computations of spillway capacity based upon approximate hydrologic assumptions, and sound engineering judgement.

c. Validity - A comparison of record data and visual observations reveals no observable significant discrepencies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General - The general appearance of the dam is good. Inspection did reveal some areas requiring monitoring.

b. Dam - The reservoir level was at approximately El. 295.6 at the time of our field inspection.

Crest - The crest is grass covered and in good condition with no signs of erosion, as shown in Photo 7.

Downstream Slope - The downstream slope is grass covered with a toe drain covered by processed stone running along the length of the dam. There are no signs of sloughing of erosion on the slope, and the toe drain is in good condition and clear of debris and vegetation, as shown in Photo 5. The toe drain outlet pipe exits from the left gabion wall as shown in Photo 6. The owner reported that water has never been observed flowing from the drain pipe.

Upstream Slope - The upstream slope is protected with riprap. A few feet of riprap could be ovserved below the waterline and appeared to be in good condition, while the upper three feet of riprap above the waterline is covered with grass and some sod.

Downstream Seepage - There is a wet area about 30 feet by 30 feet in size immediately downstream of a berm built against the downstream slope of the dam and the left abutment. The berm was placed in 1973 to cover a seep observed during construction at Station 3+45, 44 feet downstream of the dam centerline. Significant seeps within the wet area were seen at about Station 3+40, 95 feet downstream of the centerline and at about Station 3+30, 120 feet downstream of the centerline. The flow from the latter seep is roughly estimated at several gallons per minute (Photo 8). None of the seeps show evidence of soil transport. The water contained rust-colored floccules which became more abundant when shaken loose by the action of walking just upstream of the seep. The water from the seeps feeds a stream flowing from the left abutment about 200 feet downstream of the dam centerline. It is possible that the observed wet area is due to groundwater flow from the abutment rather than from the reservoir.

A seep was also observed at about Station 1+40, 150 feet downstream of the dam centerline. Flow was small and does not appear to carry any soil.

Spillway - The spillway is in good condition as shown in Photo 1. Cracks in the concrete wingwalls have been sealed with silicone caulking as shown in Photo 3. The concrete wingwalls were extended by means of gabions which are presently in good condition although some erosion of the downstream slope behind the gabions has occured (Photo 2). There is also a slight tilting of the gabions over the left wingwall.

c. Appurtenant Structures - The intake structure housing the gate valves for the low level intakes and outlets is in good condition. The exterior concrete is well maintained and the gate valves are all operational.

A series of piezometers exists at the crest and along the downstream slope at Station 1+40. The piezometers are standpipes with 3/16 inch I.D. plastic tubes inside them. Attempts were made to read the piezometers on two occasions with two different devices, but apparent obstructions were encountered preventing the instruments from reaching the water level. In some cases, readings were obtained, but it is not certain whether they correspond to a water level or an obstruction, and thus are not reported. In piezometer No. 8, there was ice filling the top of the pipe containing the piezometer lead tube. Piezometer locations are shown on the plan sheet of Killingworth Reservoir Dam in Appendix Section B.

d. Downstream Channel - The spillway channel is lined with gabions immediately downstream of the spillway apron, and appears to be in good condition.

3.2 Evaluation

Based upon the visual inspection, it was possible to assess the dam as being generally in good condition. The following features which could influence the future condition and/or stability of the dam were identified.

1. Erosion behind the gabions could increase and eventually lead to deterioration of the downstream slope.

2. The seeps observed downstream of the dam indicate that probably the flow of water occurs through the foundation soils rather than through the dam. Piezometer readings taken in 1974 indicate a loss in head through the core of about 10 feet and a piezometric surface well below the downstream slope and just below the drain. The seep at Station 1+40 is about 80 feet

downstream of the toe and at about the same elevation as the toe. Thus, the origin of the seep is probably a more pervious layer in the foundation below the piezometers such as the top portion of bedrock. Because of their location, the seeps do not present an immediate problem. However, they should be inspected as part of the owner's routine inspection program with attention given to changes in rate of flow or any evidence of soil transport.

It is our understanding that consideration is being given to building a new dam to replace the present dam. The new dam is to be located immediately downstream of the present dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Regulatory Procedures

There are two inlets to the intake chamber. The upper butterfly valve is no longer used and the low level 16 inch valve inlet is open continuously. The 16 inch outlet pipe from the intake chamber is not used. A 16 inch pipe running directly from the reservoir through the intake chamber is used to regulate the water being supplied to Kelseytown Reservoir and is usually opened from late June to mid-October when the lake level drops to 1.5 feet below the spillway crest. The 6 inch mud gate valve outlet is usually operated twice a year to flush it out.

4.2 Maintenance of the Dam

The dam is inspected monthly by the owner's engineering technician 10 months of the year and by the owner's engineer and insurance agent for the other two months. The dam is patrolled twice a day every day at which time the spillway, toe drain, and stream are checked for blockage or debris and the dam is checked for trespassing, animal burrowings, or other unusual activity. Embankments and foundations are inspected at regular intervals using a standard inspection form. Tree growth is prevented from encroaching on filled area, and the grass is cut at the end of June and August. Seepage areas are inspected twice a month by the Division Manager. Any seasonal maintenance is performed on an as needed basis.

4.3 Maintenance of Operating Facilities

The gate valves are checked periodically. Prior to our inspection, the 16 inch and 6 inch outlets from the intake structure were last opened in 1972. The 16 inch low level outlet not normally used was opened for our inspection. Maintenance is on an as-needed basis. Equipment for an aeration system installed on the reservoir bottom is checked once a week by the pump station attendent and maintained as needed.

4.4 Description of Any Formal Warning System In Effect

A very detailed comprehensive system of emergency procedures has been established and is published in the operations manual which is included in Appendix Section B. The procedures include handling of emergencies at the dam itself, notification of the public officials or agencies, in this case the Civil Defense in Clinton, and notification of any downstream residents in potential flood areas.

4.5 Evaluation

The operation and maintenance procedures for this dam are very good. The only maintenance needed would be to render the piezometers described in Section 3 operable, if it is possible to do so.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General - The reservoir is utilized primarily as a storage facility to regulate the water levels in the downstream Kelseytown Reservoir, especially during the higher-demand summer months. Although the initial impact area is immediately downstream of Kelseytown Reservoir at 2 residences, approximately 2 miles further downstream at Bushy Pond there are numerous low lying houses which have been flooded previously during heavy storms.

b. Design Data - No computations could be found for the original dam construction, the 1938 reconstruction, or the 1973 slope alterations.

c. Experience Data - No information on serious problem situations arising at the dam were found, and it does not appear the dam has been overtopped. The maximum height of water over the spillway was 0.9 feet during storm Ken in January of 1978.

d. Visual Observations - A culvert under an access road just downstream of the dam may be washed out during severe flooding, however flow from the spillway would likely not be affected.

e. Test Flood Analysis - The test flood for this high hazard, intermediate size dam is equivalent to the Probable Maximum Flood (PMF).

Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges", dated March, 1978, peak inflow to the reservoir is 3500 cfs (Appendix D-8); peak outflow (Test Flood) is 2560 cfs with the dam overtopped 0.9 feet (Appendix D-12). Based upon our hydraulics computations, the spillway capacity is 920 cfs. (Appendix D-10). The spillway will pass approximately 36 percent of the 2560 cfs Test Flood at elevation 299 (top of dam elevation). If a smaller storm equivalent to one-half the PMF if considered, the reservoir storage capability is such that the peak inflow of 1750 cfs would result in a peak outflow of approximately 980 cfs, of which the spillway will pass 94 percent.

f. Dam Failure Analysis - Utilizing the April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs", the peak failure outflow from the dam breaching would be 24,500 cubic feet per second, which, after being routed through Kelseytown Reservoir by assuming no failure of its dam, would result in an 9.7 foot wave immediately downstream at the 2 residences in the initial impact area.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - The visual observations did not disclose any evidence of instability in the dam or its appurtenances. The gabions over the left spillway wing wall are tilted slightly.

b. Design and Construction Data - The design and construction data indicates that concern for the stability of the dam led, in 1973, to the flattening of the downstream slope and the installation of a toe drain. Stability computations which may have been made at the time were not available for review, and thus the evaluation of stability is based on visual inspection and on a review of available records, such as the piezometer readings which are included in Appendix Section B.

c. Operating Records - There were no available operating records indicating any instability of the dam or its appurtenances since the 1938 reconstruction.

d. Post Construction Changes -The 1973 flattening of the downstream embankment slope represents a significant improvement in the stability of the dam. No other post-construction changes since the 1938 reconstruction are known.

e. Seismic Stability - The dam is located in Seismic Zone 1 and in accordance with the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - Based upon the visual inspection of the site and its past performance, the dam appears to be in good condition. No evidence of structural instability was observed in the dam or its appurtenances. There are some areas of seepage requiring monitoring.

Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges" dated March, 1978, peak inflow to the reservoir is 3500 cubic feet per second; peak outflow (Test Flood) is 2560 cubic feet per second with the dam overtopped approximately 0.9 feet.

Based upon our hydraulics computations, the spillway capacity is 920 cubic feet per second, which is equivalent to approximately 36 percent of the routed Test Flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the dam must be based on the visual inspection and the past performance of the dam, and sound engineering judgement.

c. Urgency - The recommendations and remedial measures presented in Sections 7.2 and 7.3 should be implemented within 2 years of the owner's receipt of this report.

d. Need for Additional Investigation - There is a need for additional investigation as recommended in Section 7.2

7.2 Recommendations

1. Based upon the rough computations in Appendix Section D, the dam spillway capacity will be exceeded by the Test Flood. More sophisticated flood routing should be undertaken by hydrologists/hydraulics engineers to refine the Test Flood figures. A study should be undertaken and recommendations made to increase the spillway capacity based upon the refined Test Flood figures.

7.3 Remedial Measures

a. Operation and Maintenance Procedures - The owner should incorporate the following measures into the operation and maintenance plan for the dam.

1. The areas of seepage described in Section 3 should continue to be monitored twice a month. A record of seepage, complete with photographic evidence, should be kept with specific attention to be focused on changes in rates of flow and soil transport.

2. The piezometers should be rendered operable if possible, and read on a periodic basis. Records of readings should be kept.

3. The present system of monthly inspection of the facility is good and should be continued. Future inspections should include the operation of all gates and/or valves at least twice a year.

4. The surface erosion of the downstream slope behind the spillway channel gabions should be repaired and steps should be taken to preclude future erosion.

7.4 Alternatives

This study has identified no alternatives to the above recommendations and remedial measures, short of the construction of the presently proposed new dam designed to replace the existing dam.

APPENDIX

SECTION A: VISUAL OBSERVATIONS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT KILLINGWORTH RESERVOIR DAM DATE: 12/19/78

TIME: 8:00 AM

WEATHER: SUNNY, 30°

W.S. ELEV. 295.6 U.S. _____ DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. PETER HEYNEN (PMH), & CALVIN GOLDSMITH (CRG)		CAHN ENGINEERS
2. GONZALO CASTRO (GC), & CHARLES OSGOOD (CO)		GEOTECHNICAL ENGRS. INC.
3. KEN KELLS, FRED BLOOM, JOHN KING		CONNECTICUT WATER CO.
4. JOHN ROBERTS		HARTFORD INSURANCE GROUP
5.		
6.		

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	DAM EMBANKMENT	PMH, CRG, GC, CO	
2.	GATE HOUSE	CRG	
3.	OUTLET PIPES	PMH, CRG, GC, CO	
4.	SPILLWAY AND CHANNEL	PMH, CRG, GC, CO	
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

PERIODIC INSPECTION CHECK LIST

PROJECT KILLINGWORTH RES. DAM DATE 12/19/78

PROJECT FEATURE DAM EMBANKMENT BY PMH, CRG, GC, CO

AREA EVALUATED		CONDITION
DAM EMBANKMENT		
Crest Elevation		299
Current Pool Elevation		295.6
Maximum Impoundment to Date		322 MG+
Surface Cracks		NONE OBSERVED
Pavement Condition		NA
Movement or Settlement of Crest		NONE OBSERVED
Lateral Movement		NONE OBSERVED
Vertical Alignment		TOO IRREGULAR TO JUDGE
Horizontal Alignment		TOO IRREGULAR TO JUDGE
Condition at Abutment and at Concrete Structures		GOOD
Indications of Movement of Structural Items on Slopes		UPSTREAM RIPRAP DISPLACED DOWN SLOPE SLIGHTLY
Trespassing on Slopes		NONE - CLOSELY PATROLLED
Sloughing or Erosion of Slopes or Abutments		NONE OBSERVED
Rock Slope Protection-Riprap Failures		ONLY SLIGHT DISPLACEMENT
Unusual Movement or Cracking at or Near Toes		NONE OBSERVED
Unusual Embankment or Downstream Seepage		SOME SEEPAGE AT FAR LEFT END OF DAM ON D/S SIDE-NOT A SERIOUS PROBLEM
Piping or Boils		NONE OBSERVED
Foundation Drainage Features		NONE OBSERVED
Toe Drains		CONTINUOUS ALONG D/S TOE OF DAM EMBANKMENT
Instrumentation System		PIEZOMETERS IN DAM

PERIODIC INSPECTION CHECK LIST

PROJECT KILLINGWORTH RESERVOIR DAM DATE 12/19/79

PROJECT FEATURE GATE HOUSE BY CRG

AREA EVALUATED		CONDITION
OUTLET WORKS-CONTROL TOWER		LOWER ORIGINAL PORTION OF REINFORCED CONCRETE
a) Concrete and Structural		UPPER PORTION OF BRICK AND MORTAR
General Condition		GOOD
Condition of Joints		GOOD
Spalling		SOME, BUT NOT A [illegible]
Visible Reinforcing		NONE
Rusting or Staining of Concrete		NONE OBSERVED
Any Seepage or Efflorescence		NONE OBSERVED
Joint Alignment		GOOD
Unusual Seepage or Leaks in Gate Chamber		NONE OBSERVED
Cracks		NONE OF IMPORTANCE OBSERVED SEAMS CAULKED W/ SILICONE MIXTURE
Rusting or Corrosion of Steel		NONE OF IMPORTANCE OBSERVED
b) Mechanical and Electrical		
Air Vents		N/A
Float Wells		N/A
Crane Hoist		N/A
Elevator		N/A
Hydraulic System		N/A
Service Gates		OPERABLE AND IN GOOD CONDITION
Emergency Gates		OPERABLE
Lightning Protection System		N/A
Emergency Power System		N/A - GATES OPERATED BY HAND
Wiring and Lighting System		N/A

PERIODIC INSPECTION CHECK LIST

PROJECT KILLINGWORTH RESERVOIR DAM DATE 12/11/78

PROJECT FEATURE OUTLET PIPES BY AMH, CRG, GC, CO

AREA EVALUATED	CONDITION
OUTLET WORKS-OUTLET STRUCTURE AND OUTLET CHANNEL	2-16" CAST IRON LOW LEVEL PIPES
General Condition of Concrete	1-6" CAST IRON MUD VALVE
Rust or Staining	GOOD GENERAL CONDITION
Spalling	NA
Erosion or Cavitation	NA
Visible Reinforcing	NA
Any Seepage or Efflorescence	NONE
Condition at Joints	NA
Drain Holes	NA
Channel	
Loose Rock or Trees Overhanging Channel	NONE - OUTLET PIPES CLEAR, BUT NOT PROTECTED. COULD BE BLOCKED.
Condition of Discharge Channel	VERY GOOD. LINED W/ GABIONS

PERIODIC INSPECTION CHECK LIST

PROJECT KILLINGWORTH RESERVOIR DAM DATE 12/19/18

PROJECT FEATURE SPILLWAY AND CHANNEL BY PMH, CRE, CK, CO

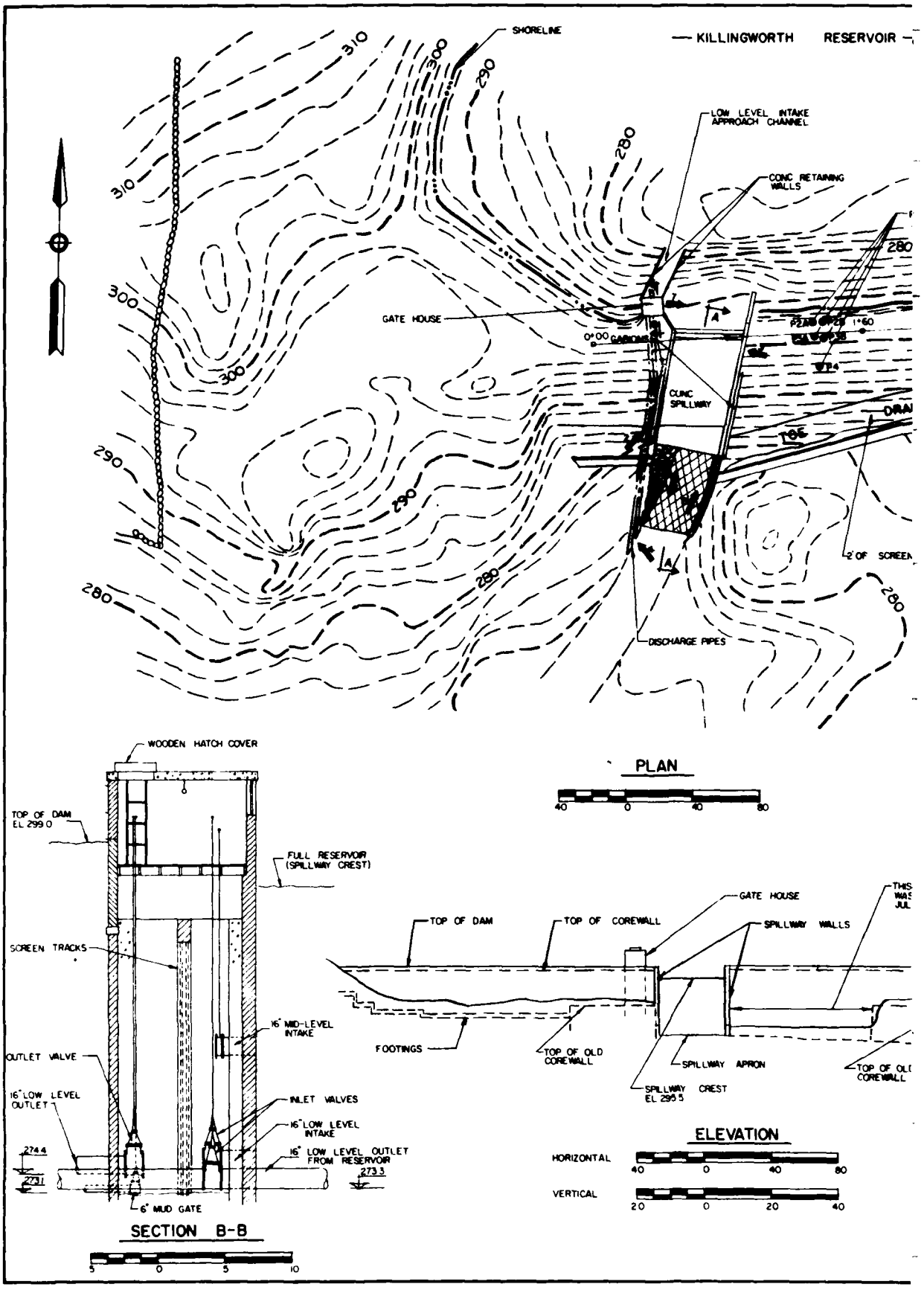
AREA EVALUATED		CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
a) Approach Channel		
General Condition		GOOD
Loose Rock Overhanging Channel		NONE
Trees Overhanging Channel		NONE
Floor of Approach Channel		NOT SILTED - AIR BUBBLE MIXING TO PREVENT SILT
b) Weir and Training Walls		
General Condition of Concrete		GOOD - SEAMS CAULKED W/ SILICONE MIXTURE
Rust or Staining		NONE OBSERVED
Spalling		NONE
Any Visible Reinforcing		NONE
Any Seepage of Efflorescence		NONE
Drain Holes		NONE OBSERVED
c) Discharge Channel		
General Condition		GOOD
Loose Rock Overhanging Channel		NONE
Trees Overhanging Channel		SOME NEAR CHANNEL
Floor of Channel		GABIONS (SIDES OF CHANNEL ALSO)
Other Obstructions		NONE

APPENDIX

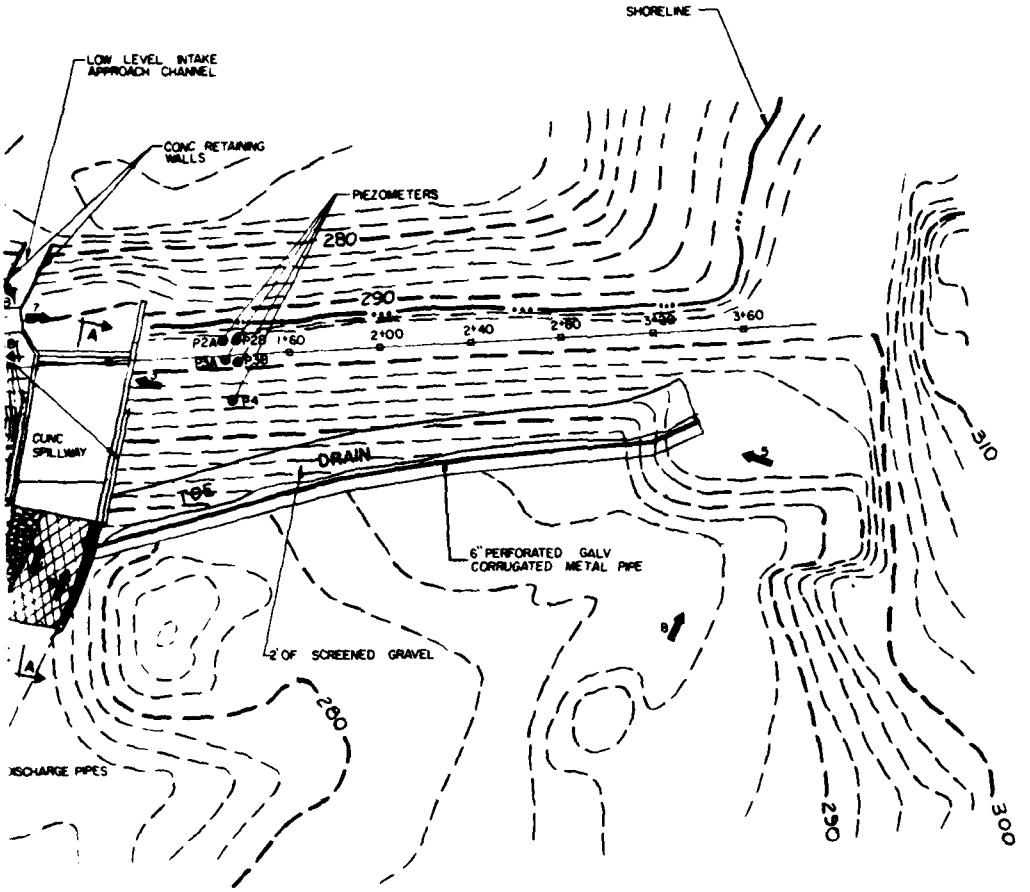
SECTION B: EXISTING DATA

APPENDIX

SECTION B: EXISTING DATA
KILLINGWORTH RESERVOIR DAM

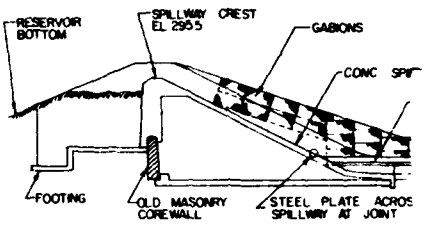

KILLINGWORTH RESERVOIR
SHORELINE
LOW LEVEL INTAKE APPROACH CHANNEL
CONC RETAINING WALLS
GATE HOUSE
GABIONS
CONC SPILLWAY
DISCHARGE PIPES
310
300
290
280
PLAN
40 0 40 80
WOODEN HATCH COVER
TOP OF DAM EL 299.0
FULL RESERVOIR (SPILLWAY CREST)
SCREEN TRACKS
16" MID-LEVEL INTAKE
OUTLET VALVE
16" LOW LEVEL OUTLET
INLET VALVES
16" LOW LEVEL INTAKE
16" LOW LEVEL OUTLET FROM RESERVOIR
274.4
273.1
273.3
6" MUD GATE
SECTION B-B
5 0 5 10
TOP OF DAM
TOP OF COREWALL
GATE HOUSE
SPILLWAY WALLS
FOOTINGS
TOP OF OLD COREWALL
SPILLWAY APRON
SPILLWAY CREST EL 295.5
ELEVATION
HORIZONTAL
40 0 40 80
VERTICAL
20 0 20 40

— KILLINGWORTH RESERVOIR —



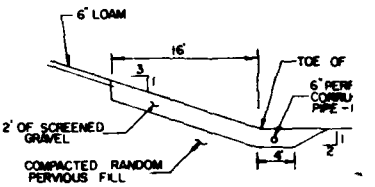
PLAN

40 0 80



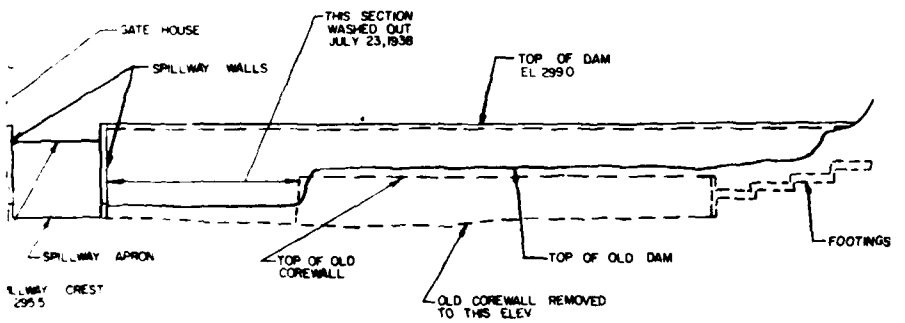
SECTION A-A

20 0 20



TOE DRAIN SECTION

10 0 10



ELEVATION

0 40 80

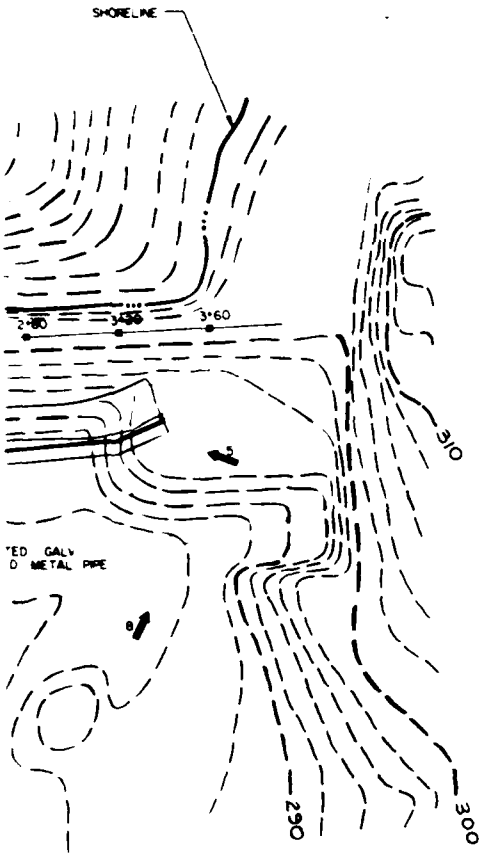
0 20 40

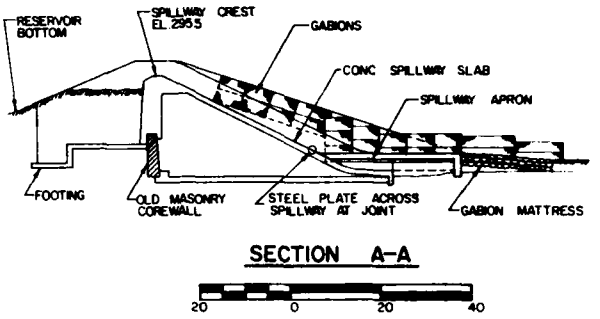
NOTES:

1. THIS PLAN WAS COMPILED ENTIRELY FOR THE DAM LISTED ON PAGE B-
2. ELEVATIONS SHOWN ARE MEAN SE
3. ← PHOTO NUMBER AND DIREC

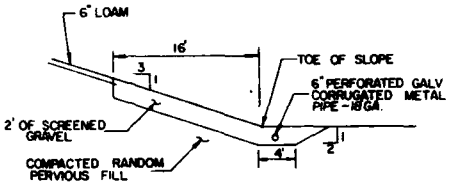
CAHN ENGINEERS INC WALLINGFORD, CONNECTICUT ENGINEER	U S ARM
NATIONAL PROGRAM OF INSP	
KILLINGWORTH RES	
TR-MENUNKETESUCK RIVER	

DRAWN BY	CHECKED BY	APPROVED BY
JJ M	CAS	PBH





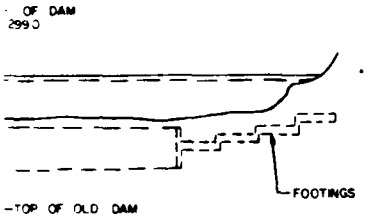
SECTION A-A



TOE DRAIN SECTION

NOTES:

1. THIS PLAN WAS COMPILED ENTIRELY FROM THE EXISTING PLANS FOR THE DAM LISTED ON PAGE B-2 OF THIS REPORT.
2. ELEVATIONS SHOWN ARE MEAN SEA LEVEL DATUM.
3. ◀ PHOTO NUMBER AND DIRECTION



CAHN ENGINEERS INC. WALLINGFORD, CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORP OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

KILLINGWORTH RESERVOIR DAM

TR-MENUNKETESUCK RIVER KILLINGWORTH, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: AS NOTED
M.N	CAS	PMH	DATE: MARCH 1979 PAGE B-1

KILLINGWORTH RESERVOIR DAM
LIST OF EXISTING PLANS

"Repairs to Upper Dam"
Guilford-Chester Water Co.
Town of Killingworth, Conn.
Chandler and Palmer, Engineers
Norwich, Conn.
Sept. 1938

"Killingworth Gatehouse"
Killingworth, Connecticut
The Connecticut Water Company
Sept. 20, 1972
(revisions-10/18/72, 10/20/72, 1/12/73, 12/11/78)

"Alterations to Killingworth Reservoir Dam"
Metcalf and Eddy, Inc., Engineers
Boston, Mass.
July 3, 1973
(revised to as-built condition 4/11/78 and 12/6/78)

SUMMARY OF DATA AND CORRESPONDENCE

DATE	TO	FROM	SUBJECT	PAGE
June 5, 1963	Files	Water Resources Commission, Supervision of Dams	Inventory Data	B-4
June 28, 1973	Water and Related Resources, Dept. of Environmental Protection, State of Connecticut	The Connecticut Water Company	Application for construction permit for flattening downstream face of dam to 3:1 slope.	B-5
July 3, 1973	William F. Guillaume Vice President-Operations The Conn. Water Company	Edward Morrison Project Engineer Metcalf and Eddy, Inc.	Gradation data pertaining to on-site and potential borrow materials.	B-6
Oct. 25, 1973	William F. Guillaume	Arthur D. Moody Project Manager Metcalf and Eddy, Inc.	Report of soft area encountered at left downstream end of dam and corresponding recommendations. (with sketch)	B-8
Dec. 7, 1973	The Conn. Water Company	Water and Related Resources	Certificate of approval of construction work.	B-11
Mar. 24, 1975	William F. Guillaume	Arthur D. Moody	Periodic plots of phreatic surface from Sept. 1973 to Dec. 1974.	B-12
1978	Files	The Conn. Water Co.	Operations and Maintenance Manual - Killingworth Reservoir.	B-18

SUPERVISION OF DAMS
INVENTORY DATA

CT-401

Inventoried By WPS

Date 5 JUNE 1963

Name of Dam or Pond KILLINGWORTH RESERVOIR

Code No. ME 9.3 U 0.5

Nearest Street Location ROUTE 80

Town KILLINGWORTH

Long 72-32.1

U.S.G.S. Quad. CLINTON

Lat 41-21.5

Name of Stream

Owner THE CONNECTICUT WATER COMPANY
WEST MAIN ST.

Address CLINTON

OK
7/73

Pond Used For WATER SUPPLY

Dimensions of Pond: Width 1000 FEET Length 4000 FEET Area ~~100~~ 80 ACRES

Total Length of Dam ~~800~~ FEET 420' Length of Spillway ~~75~~ FEET 40'

Location of Spillway WEST END OF DAM

Height of Pond Above Stream Bed 21' ~~20~~ FEET

Height of Embankment Above Spillway 4 FEET

1895 rebuilt 1930

Type of Spillway Construction CONCRETE

Type of Dike Construction EARTH

Downstream Conditions WOODS, ROUTE 80

Summary of File Data Toe drain system added 1972

Remarks

B-4

Would Failure Cause Damage? YES Class B

DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER AND RELATED RESOURCES
State Office Building
Hartford, Connecticut 06115

APPLICATION FOR CONSTRUCTION PERMIT FOR DAM

Owner The Connecticut Water Company Date June 28, 1973

P.O. Address West Main Street Tel. No. 669-8636

Clinton, Connecticut 06413

Location of structure:

Town Killingworth Shown on USGS Quadrangle Clinton, Conn.

Name of Stream None at 2 inches south of Lat. 41°22'30"

and 1 inches east of Long. 72°32'30"

Directions for reaching site from nearest village or route intersection:

From intersection of Rt. 80 and Rt. 81 in Killingworth, proceed East on Rt. 80.

This is an application for: (~~New Construction~~) (Alteration) (~~Repair~~) (~~Removal~~)
(check one or more of above)

This pond is to be used for: Drinking water supply

Dimensions of Pond: width 2,000 ft. (max.) length 4,000 ft. (max.) area 86A.

Maximum depth of water immediately above dam: 21 ft.

Total length of dam: 420 ft.

Length of spillway: 40 ft.

Height of abutments above spillway: varies

Type of spillway construction: concrete

Type of dike construction: Earthwork with masonry corewall

Spillway section will be set on: (~~Bedrock~~) (Gravel) (~~Clay~~) (~~Till~~)
(check one of above)

Remarks: Work consists of flattening downstream face of dam to 3:1 slope, raising lower portion of spillway, and appurtenant work.

Signed: Howard F. Gunderman
(owner)

Name of Engineer, if any: Metcalf & Eddy

B-5

Metcalf & Eddy, Inc. | Engineers
Statler Building/Boston, Massachusetts 02116 (617)423-5600 TWX 710 321-6365 Cable METEDD -BOSTON

July 3, 1973

J-2695

Mr. William F. Guillaume
Vice President - Operations
The Connecticut Water Company
West Main Street
Clinton, Connecticut 06413

Dear Mr. Guillaume:

Enclosed are gradation data pertaining to the suitability of on-site materials for use in flattening the slope of the Killingworth Reservoir Dam.

Sieve analyses were run on soil samples taken from the dam and from potential borrow sites at the north end of the reservoir. The analyses indicate that this borrow site area contains material suitable for use on dam.

Very truly yours,

METCALF & EDDY, INC.

Edward Morrison
Project Engineer

EM:bjs

B-6

LABORATORY NO. _____

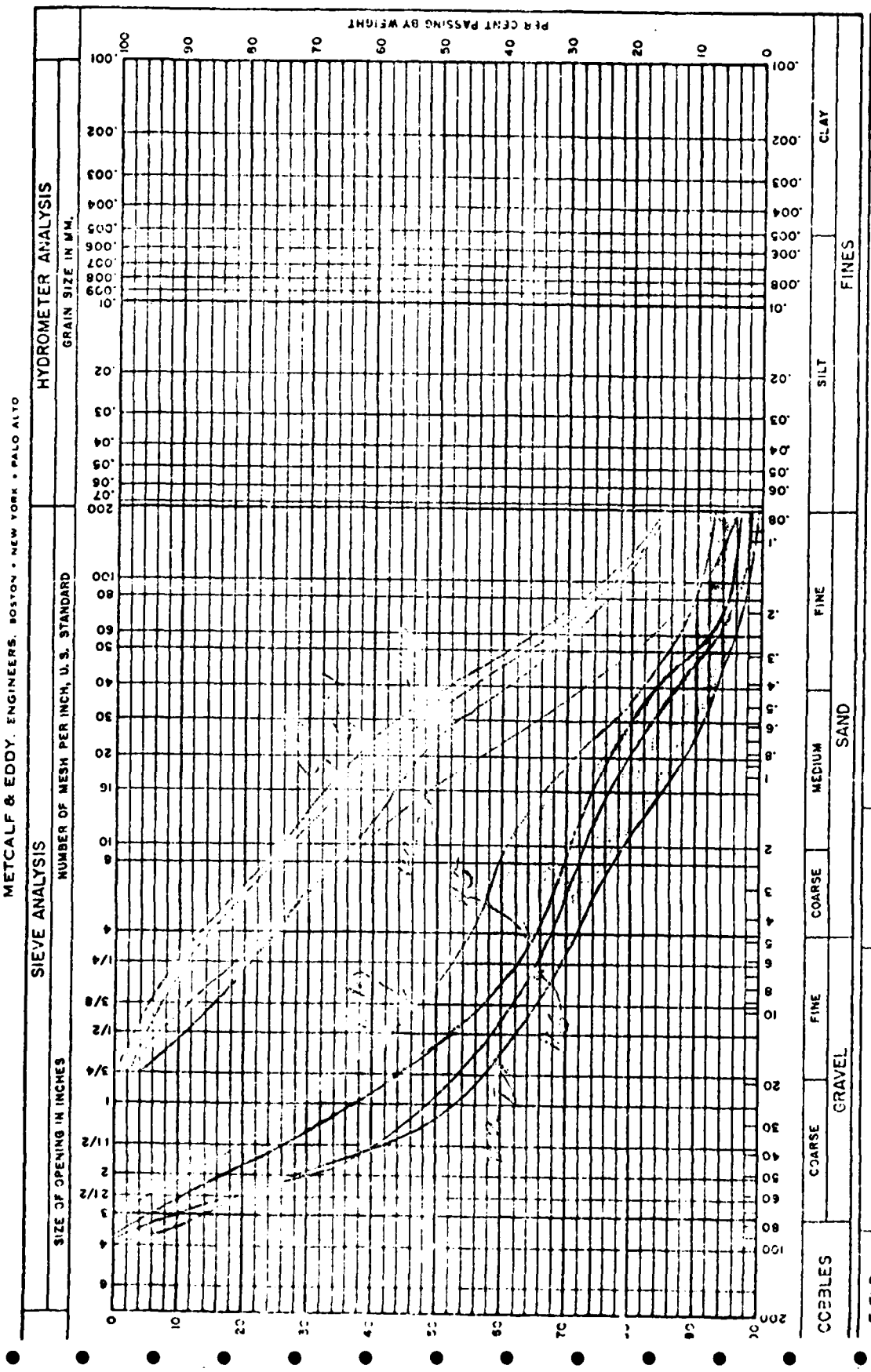
FIELD SAMPLE NOS. _____

DATE TESTED _____

ACCT. ABBR. Ewckillingworth Alt. Dam

ACCT. NO. 2695

TESTED BY _____



METCALF & EDDY, ENGINEERS, BOSTON • NEW YORK • PALO ALTO

Metcalf & Eddy, Inc. | Engineers
Statler Building/Boston, Massachusetts 02116 (617)423-5600 TWX 710 321-6365 Cable METEDD-BOSTON

October 25, 1973

CSD-2857

Mr. William F. Guillaume
Vice President - Operations
The Connecticut Water Company
93 West Main Street
Clinton, Connecticut 06413

Dear Mr. Guillaume:

During the work of flattening the downstream face of the Killingworth Reservoir Dam to a 3:1 slope, a soft area was encountered at Station 3+45, 44 feet right (downstream) of the dam centerline. Excavation of the soft area was attempted carefully noting the entrance of any water. At about 3-1/2 feet deep, water started entering the excavation from the dam side. Rather than risk any loss of material, the excavation was immediately backfilled and compacted using the same granular material being used for the slope filling.

After field review of the situation on October 18 and 19, 1973, we recommended that:

1. Fill be placed over the entire soft area to a minimum elevation of 295 ft., and

2. The filter and underdrain pipe be extended across the filled area at a depth of 3 feet below the surface.

By filling the 295, a sufficient weight of material is added to resist any tendency to lift the embankment by pressure because of blocking off a path of free drainage. By extending the underdrain across the fill, we ensure that seepage will not reach the surface, thereby, creating a wet or spongy area.

B-8

The attached sketch shows the revised configuration at the east end of the dam.

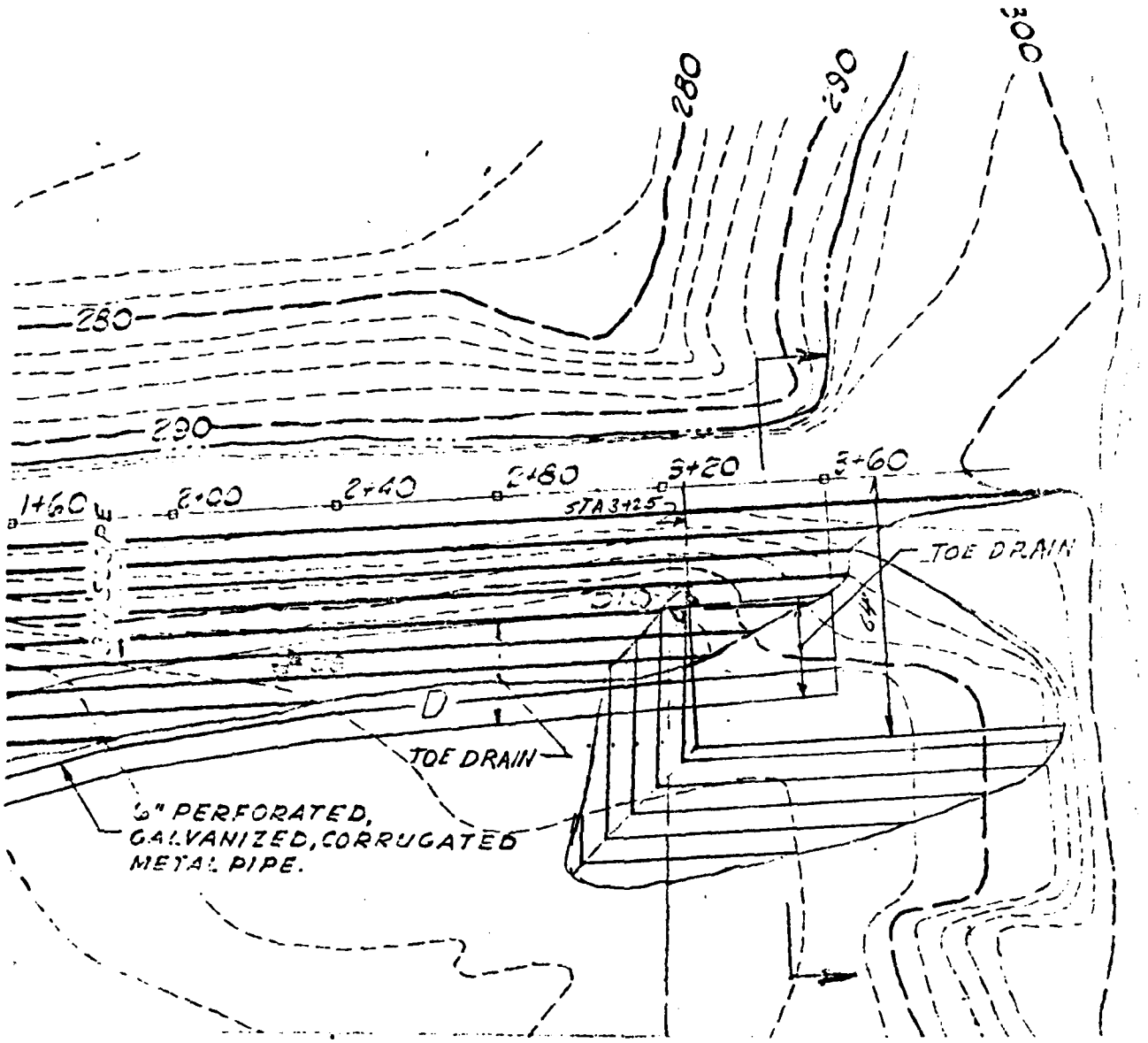
Very truly yours,

METCALF & EDDY, INC.

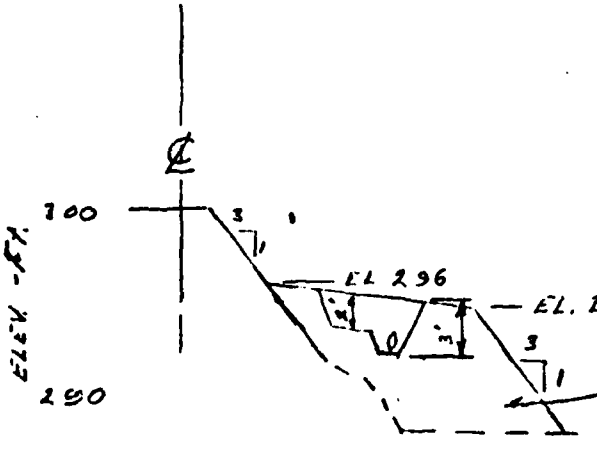
Arthur D. Moody
Project Manager

EBM:ayg

Enc.



1" = 40'



Section @ 3+40

Hor. 1" = 40'
Vert 1" = 10'

METCALF & EDDY, ENGINEERS

Z-2593/1-1

B-10

STATE OF CONNECTICUT

DEPARTMENT OF ENVIRONMENTAL PROTECTION

STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

WATER AND RELATED RESOURCES

CERTIFICATE OF APPROVAL

7 December 1973

The Connecticut Water Company
West Main Street
Clinton, Connecticut 06413

TOWN: Killingworth
RIVER: Menunketesuck River
TRIBUTARY: Unnamed
CODE NO: K-2

Gentlemen:

NAME AND LOCATION OF STRUCTURE: Killingworth Reservoir Dam located on an unnamed tributary to the Menunketesuck River in the town of Killingworth.

DESCRIPTION OF STRUCTURE AND WORK PERFORMED: Work consisted of flattening the downstream face of the existing dam to a 3:1 slope and raising the lower portion of the spillway according to plans prepared by Metcalf & Eddy, dated 3 July 1973.

CONSTRUCTION PERMIT ISSUED UNDER DATE OF: 27 July 1973

This certifies that the work and construction included in the plans submitted, for the structure described above, has been completed to the satisfaction of this department and that this structure is hereby approved in accordance with Section 25-114 of the 1971 Supplement to the General Statutes.

The owner is required by law to record this Certificate in the land records of the town or towns in which the structure is located.

B-11

Deputy Commissioner
Preservation and Conservation

TBB:ljg

Metcalf & Eddy, Inc. | Engineers & Planners
Statler Building/Boston, Massachusetts 02116 (617)423-5600 TWX 710 321-6365 Cable METEDD- BOSTON

March 24, 1975

J-2161

Mr. William F. Guillaume
Vice President - Operations
The Connecticut Water Company
West Main Street
Clinton, Connecticut 06413

Subject: Phreatic Surface
Killingworth Reservoir

Dear Mr. Guillaume:

Based upon the periodic piezometer readings obtained at the Killingworth Reservoir, phreatic surfaces, at different dates and reservoir stages, have been plotted on a typical cross section of the dam at the piezometer locations.

Examination of these plots indicates that the phreatic surface is being well contained within the reconstructed downstream slope. The maximum level shown is on January 31, 1974 and December 13, 1974, when the reservoir level was 295.7 feet or, about 0.2 feet above the spillway. With additional increase in height it would appear that the phreatic surface would be intercepted by the toe drain.

Very truly yours,

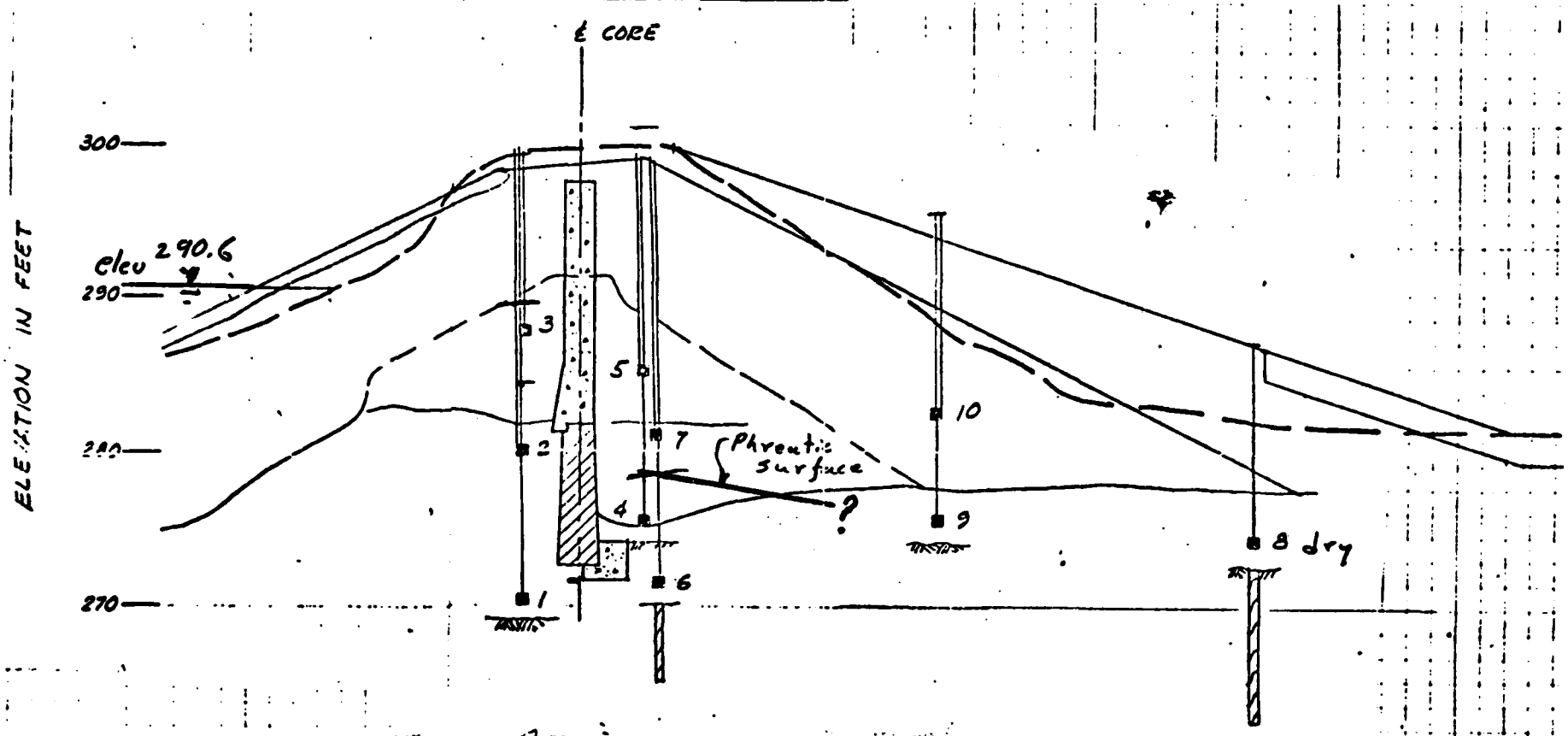
METCALF & EDDY, INC.

Arthur D. Moody
Project Manager

B-12

EBM:le

Enclosures



FULL RESERVOIR IS

NOTES:

1. NUMBERS = PIEZOMETER NUMBER
2. ■ = PIEZOMETER LOCATION
3. ⫫ = REFUSAL
4. ⊤ = ROCK CORE

0 10 20
Scale

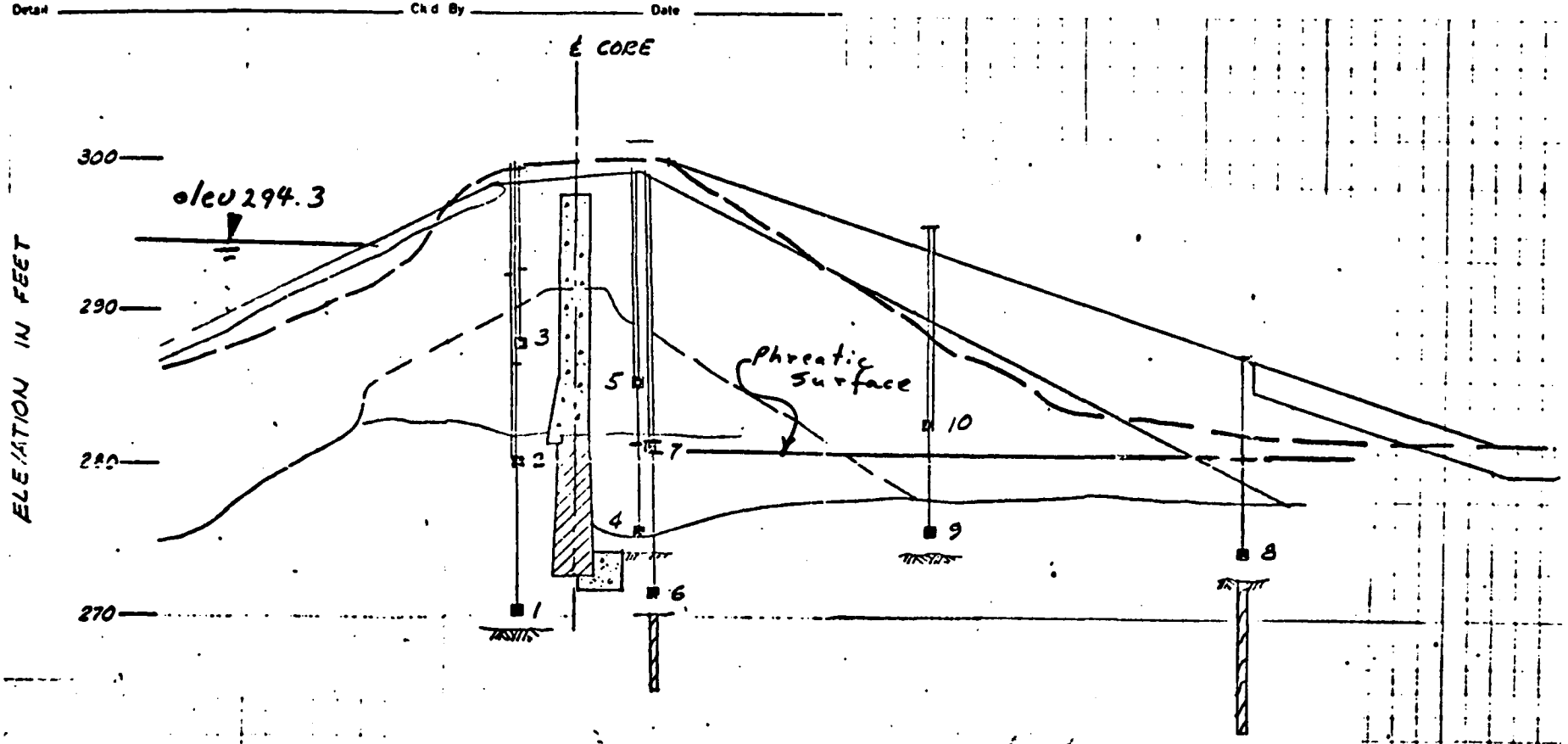
B-13

9/27/73

Proj. No. Page of

Sul Leg Pmpld '28'

Detail Ck'd By Date



RESERVOIR

NOTES:

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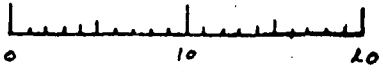
2. ■ = PIEZOMETER LOCATION
3. ⫫ = REFUSAL
4. ⊤ = ROCK CORE

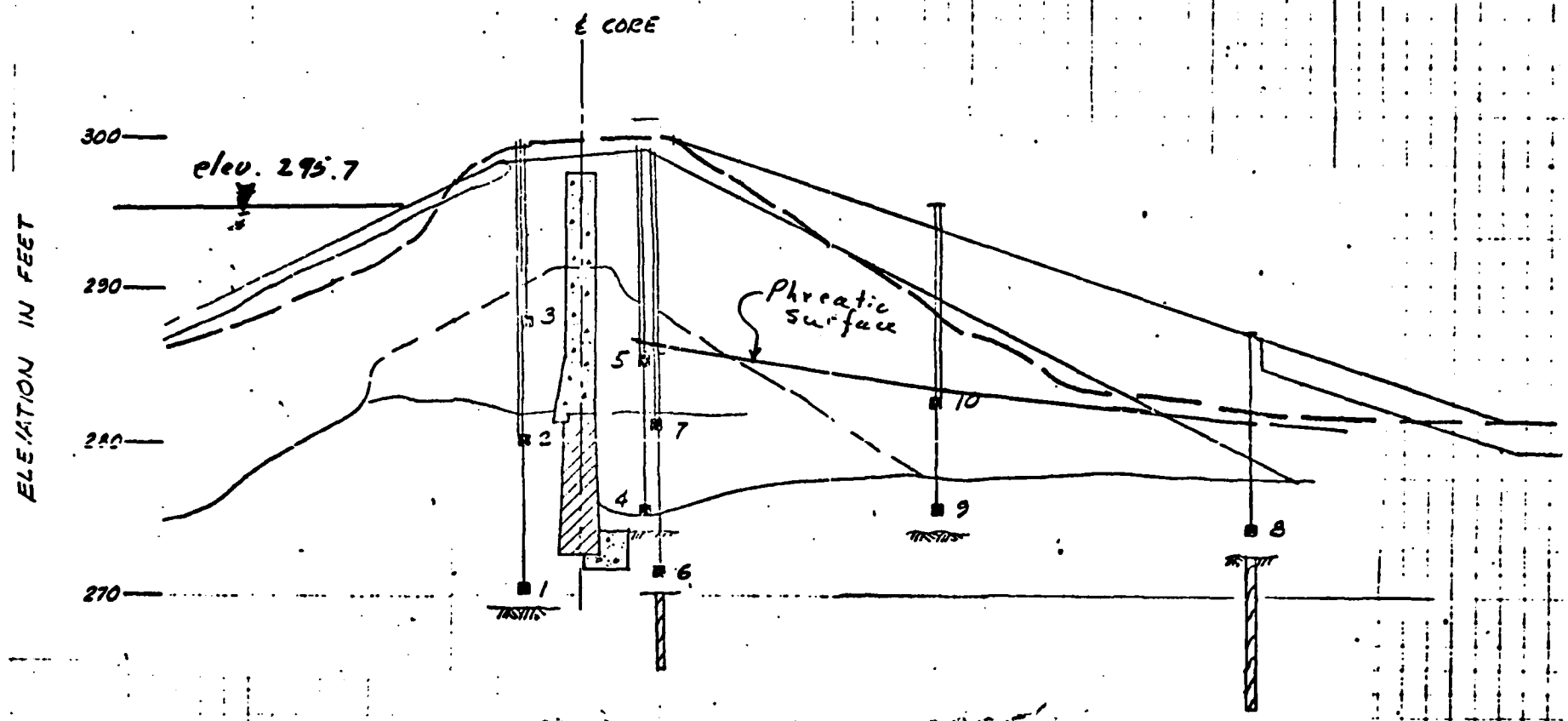


12/28/73

Project [illegible] Acct No. 1161

Subject Piezometer Levels Compld By [illegible] Date 1/31/74

Detail [illegible] Ck'd By [illegible] Date [illegible]



NOTES:

1. NUMBERS = PIEZOMETER NUMBER
2. ■ = PIEZOMETER LOCATION
3. ⫫ = REFUSAL
4. ⊤ = ROCK CORE

0 10 20

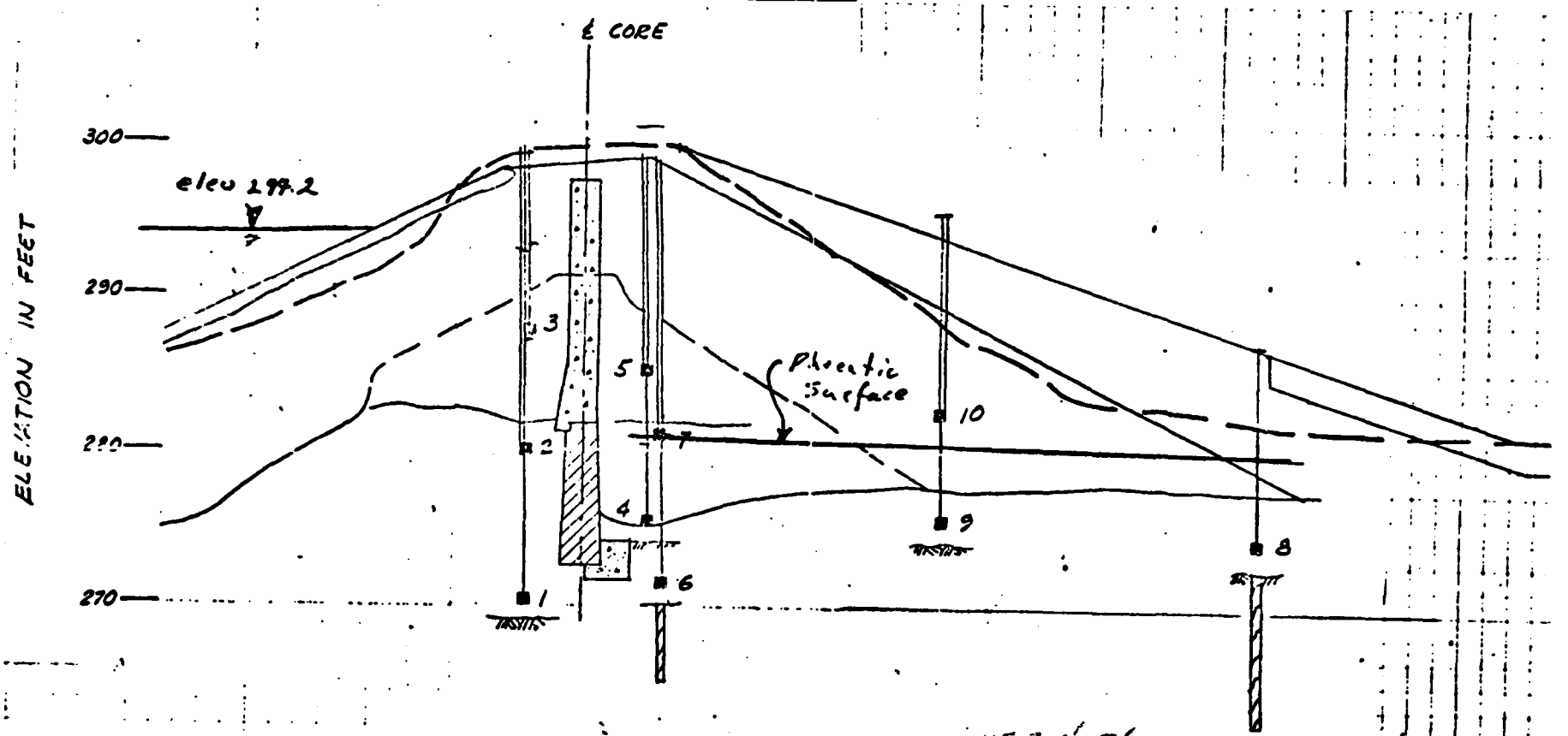
Scale

1/31/74

Project _____ Acct No. 161 Page _____ of _____

Subject _____ Compld. By _____ Date 11/8/74

Detail _____ Ch'd By _____ Date _____



NOTES:

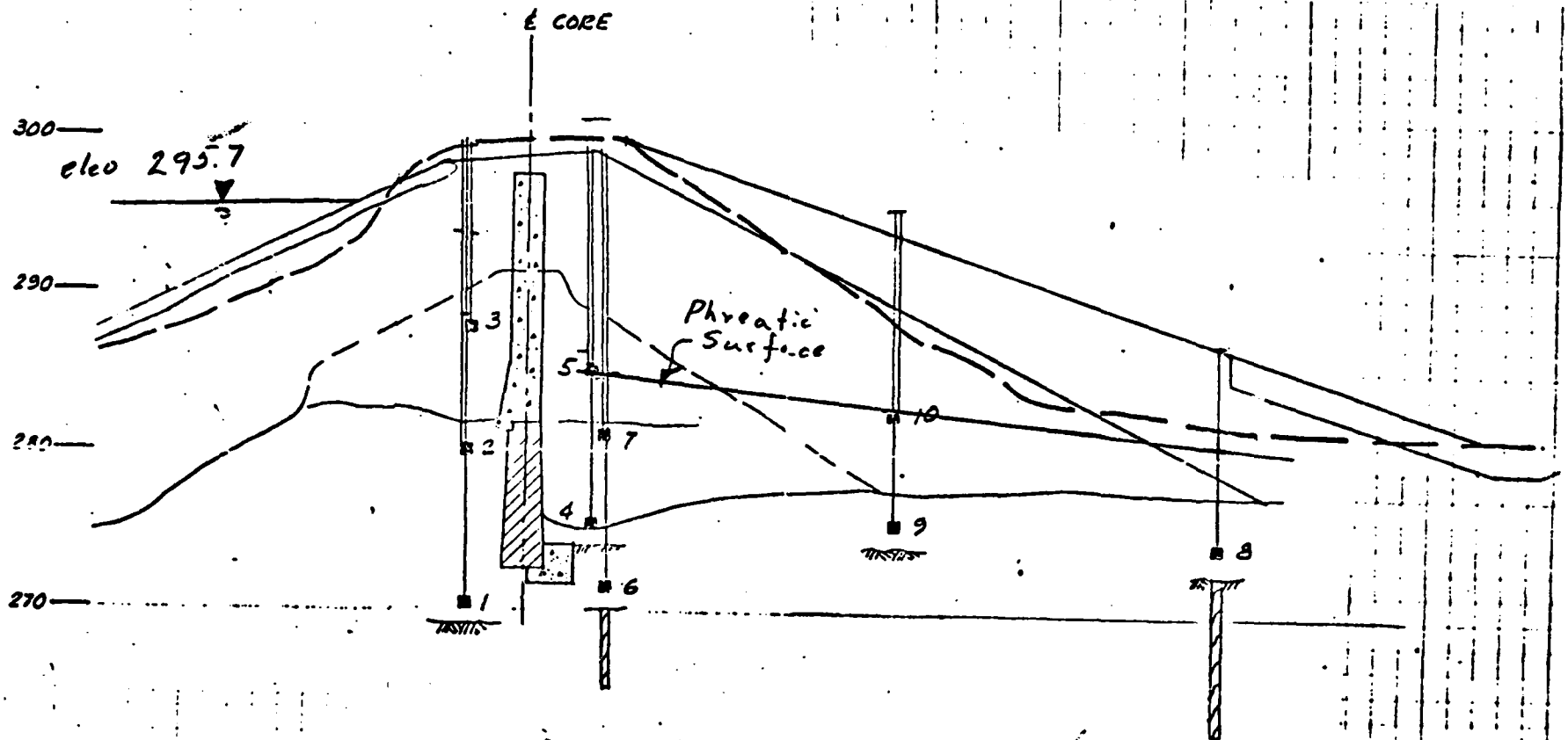
1. NUMBERS = PIEZOMETER NUMBER
2. ■ = PIEZOMETER LOCATION
3. ⫫ = REFUSAL
4. ⊤ = ROCK CORE

0 10 20
Scale

11/8/74

Subject Piezometer levels Compld. By [illegible] Date 12/13/74

Detail Ck'd. By Date



NOTES:

1. NUMBERS = PIEZOMETER NUMBER
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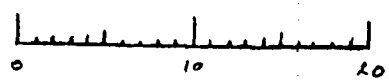
3. ⫻⫻ = REFUSAL
4. ⊤ = ROCK CORE



12/13/74

OPERATIONS AND MAINTENANCE MANUAL

KILLINGWORTH RESERVOIR

Patrolman - Walter Albrecht		663-1535
Division Manager - Fred Bloom	office	669-8636 ext. 40
	home	669-7383
Standby (Clinton Answering Service)		669-5338
Chief Engineer - William Guillaume		669-5463
Construction Engineer - Kenneth Kells		767-0535
Quality Engineer - James McQueen		388-3914
Killingworth Police		346-6616
Clinton Police		911
DEP - Spill		566-3338

KILLINGWORTH RESERVOIR

Killingworth Reservoir is a water storage reservoir for the Guilford-Chester Division of The Connecticut Water Company. It is located approximately 1,000 feet north of Route 80 and 10,000 feet east of Route 81 in Killingworth, Connecticut. The storage capacity of the reservoir is 220,625,500 gallons. The flow over the spillway or through the gatehouse feeds a tributary of the Menunketesuck River which leads to Kelseytown Reservoir. The purpose of this reservoir is to maintain the level of water at Kelseytown.

When the level of Kelseytown drops to 1½ feet below spilling, the valve marked 16" blowoff gate valve in the gatehouse of Killingworth Reservoir is opened seven full turns to augment Kelseytown. This is the normal flow out of the reservoir and equals approximately 2.0 MGD. It usually takes about 24 hours for this flow of water to have an effect at Kelseytown. As more or less water is needed at Kelseytown, the gate is adjusted accordingly. This is accomplished by the Division Manager and is based on weather conditions and the level of water at Kelseytown. In general, the valve is opened from late June to mid October. The average summer drawdown is about four feet. During the drought of 1964, the level of the reservoir was down 10.5 feet. See attached graphs. Flood flows have been read as high as 16.90 feet (0.9 feet) over the spillway. This occurred during storm "Ken" in January 1978. Generally the reservoir is down when hurricanes come which allow for some storage.

Four other gates are present in the gatehouse of Killingworth. See CWC drawing GC-81. They are labeled on the floor of the gatehouse as follows:

16" lower inlet
16" upper inlet
16" lower outlet
6" mud gate

It is important to realize that the screens in the gatehouse have been removed and the augmenting flow through the 16" blowoff is actually the drain valve for the reservoir. All gatevalves were last operated in 1972.

The entrance to Killingworth has been fenced and the access gate is locked at all times. The reservoir is patrolled twice a day at various hours. His patrol of the area includes:

a.) A check of the spillway for debris and obstacles
b.) A check of the stream downstream of the spillway
c.) A check of the drainage from the toe drain, and
d.) Any unusual activities, e.g. motorcycles, horseback riders, dead animals, a[illegible] burrows, etc.

Trespassing is not allowed on Water Company lands. All problems and violations are reported to the Division Manager as soon as possible. In addition to the patrolman, once a week the pump station attendent inspects and maintains the aeration equipment at the reservoir.

Inspections of embankments and foundations are inspected at regular intervals using form CWC E-19. A copy of a typical inspection report is attached. Tree growth along the artificial fill area is closely monitored and should not encroach upon fill area. Visual inspections of seepage areas are done twice a month by the Division Manager. Seasonal maintenance is done as required.

The stream crossing downstream of the spillway is maintained by the Water Company. Water quality of the Killingworth Reservoir is monitored and sampled regularly. Water Company lands near the reservoir are managed by Connwood of Rockfall, Connecticut. The long range plan for Killingworth Reservoir includes increasing the storage capacity. Preliminary plans have been developed.

Copies of this manual are distributed to the Division Manager, Patrolman, and Engineering Department.

Additional reference for Killingworth Reservoir

1.) Reservoir & Dam Inspection Reports, G-C Division
2.) Surface Water Book
3.) Flood Levels
4.) CAC 1140, 1239 and 1729

VFS/bc
12/12/78

EMERGENCY PROCEDURES

FLOODING OR THREATENED FLOODING

When the weather or weather forecast indicates a potential for flooding, the following procedures shall be initiated by the Division Manager and maintained throughout the flooding or threatened flooding period. These procedures apply to the Killingworth Reservoir.

1.) Alert sufficient men and officers to standby status so available when needed.

2.) Maintain a log of incidents, actions taken and other pertinent data.

3.) Check inlet screens more frequently to make sure not plugged or damaged.

4.) Open blowoffs and drop reservoir levels where applicable. Be careful that opened blowoffs don't aggravate a flooding or erosion problem downstream.

5.) Doublecheck spillways to make sure clear of all debris and other obstacles.

6.) Check drainageway upstream and downstream from our source to make sure that all culverts, bridges, narrow channels, etc., are clear of obstructions. The upstream check is to prevent temporary log jamming or culvert blocking that might later be released and cause swamping of the source. The downstream check is to prevent backwater flooding. Any potential obstructions noted shall be reported to the state, town highway or other responsible official. If unavailable or no action is taken, the D.M. shall arrange for its removal if the flood threat is serious.

An accurate and current watershed map must be available to aid in selecting sites to check. (See Surface Water Book)

7.) Sandbag materials should be arranged for prior to actual usage when suppliers are available. Life jackets should be available for men working in or over flood waters.

8.) Sea serpents and other oil containment facilities should be arranged for in case of vehicular or non-vehicular oil spills on watersheds. A list of pollution control companies should be available with names, addresses, telephone numbers and other pertinent data. (See catalog file: Oil Spill Cleanup)

9.) Report <u>any</u> oil spill to the State Department of Environmental Protection, telephone 566-3338, Hartford, during normal office hours. At other hours, call State Police.

10.) After heavy winds or heavy rainfall, but before flooding, doublecheck drainageways, spillways, culverts and bridge again. Check entire dam for beginnings of possible washout. If any questionable areas, repair or contact Engineering Department for immediate inspection.

11.) Check all facilities for effects of erosion or other water damage. Include elevated storage tanks, standpipes, concrete basins, diversion works, wells, pumping stations, dam, dikes, offices, storage sheds and storage areas. Take the necessary corrective or precautionary measures to prevent or minimize loss. For structures like elevated storage tanks and pumping stations, pay particular attention to erosion near the foundations.

12.) Where necessary, get power company to cut off power to stations subject to flooding. Remove chemicals, especially fluoride and chlorine, to prevent safety hazards when entering building later.

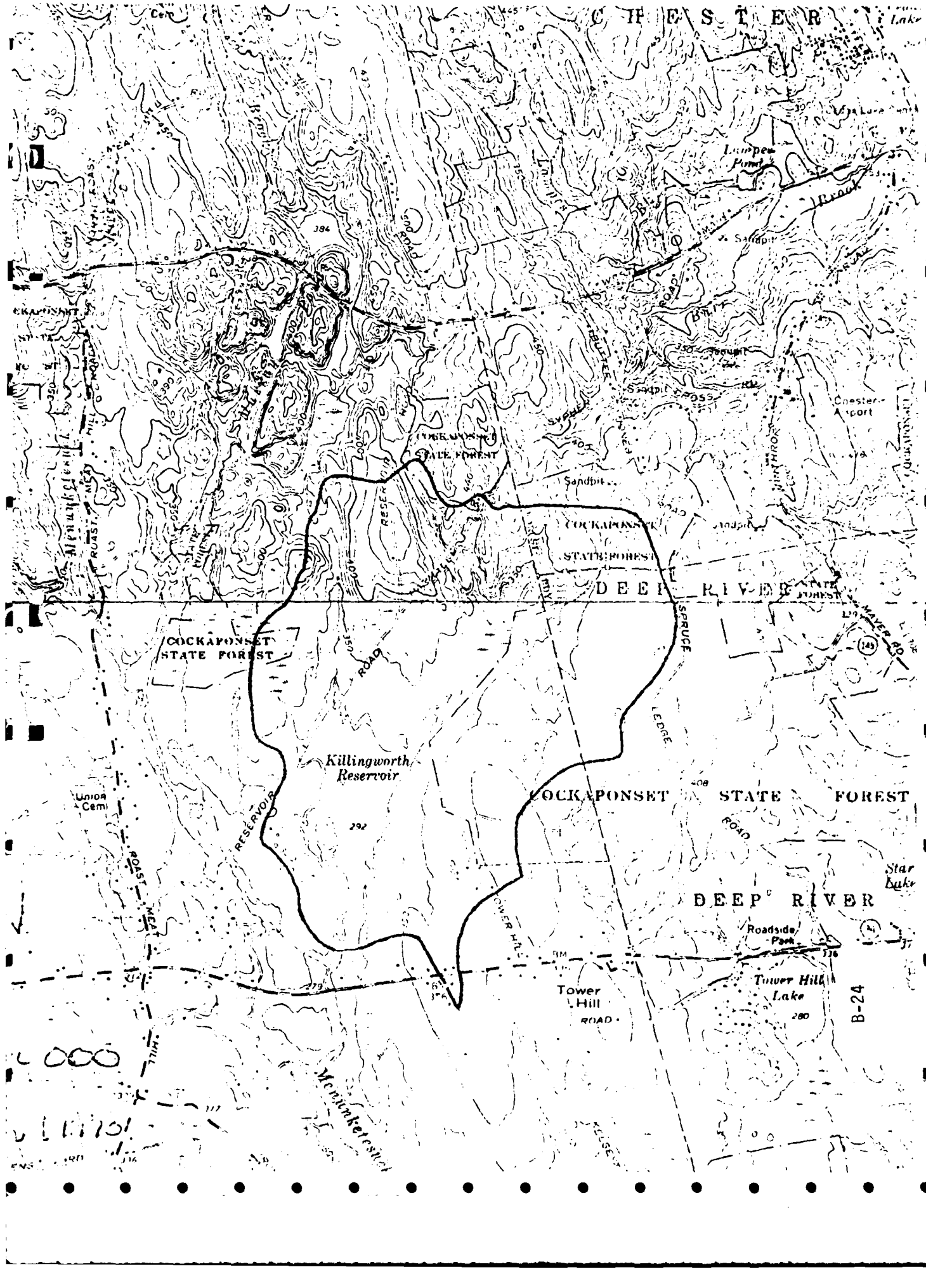
13.) When high water occurs, maintain a watch at the sources, sandbagging where necessary to contain overflow in spillway or other location safe from serious erosion. Check downstream of dam on dam face and below, for active or potential water boils and sandbag around them as needed.

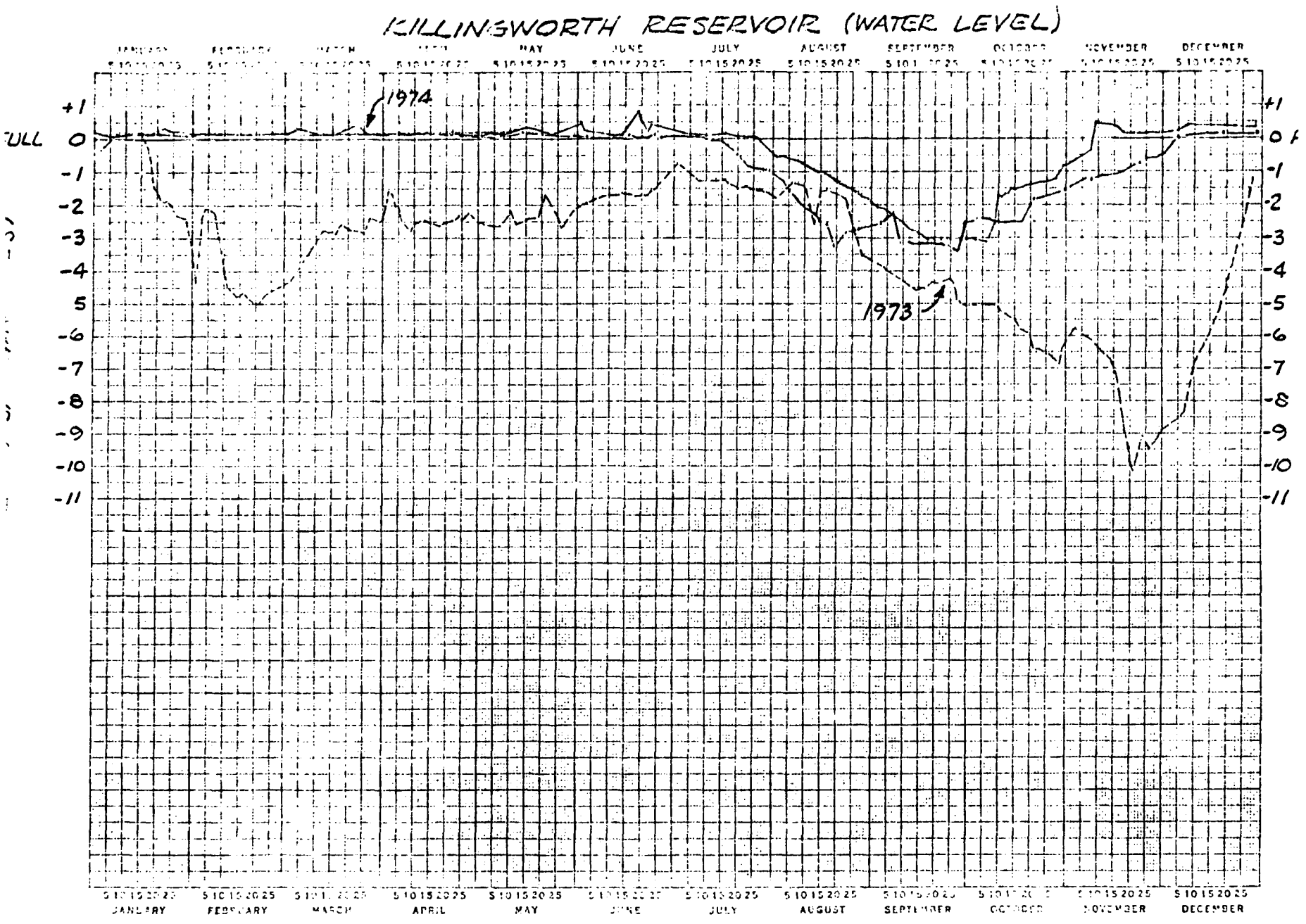
14.) Where unusually high flow over the spillway of one of our reservoirs may affect downstream flooding, set up a reporting system with the local Civil Defense, police, fire or other responsible agency and give them data on flow over the spillway. This may aid them in deciding when to evacuate downstream dwellings.

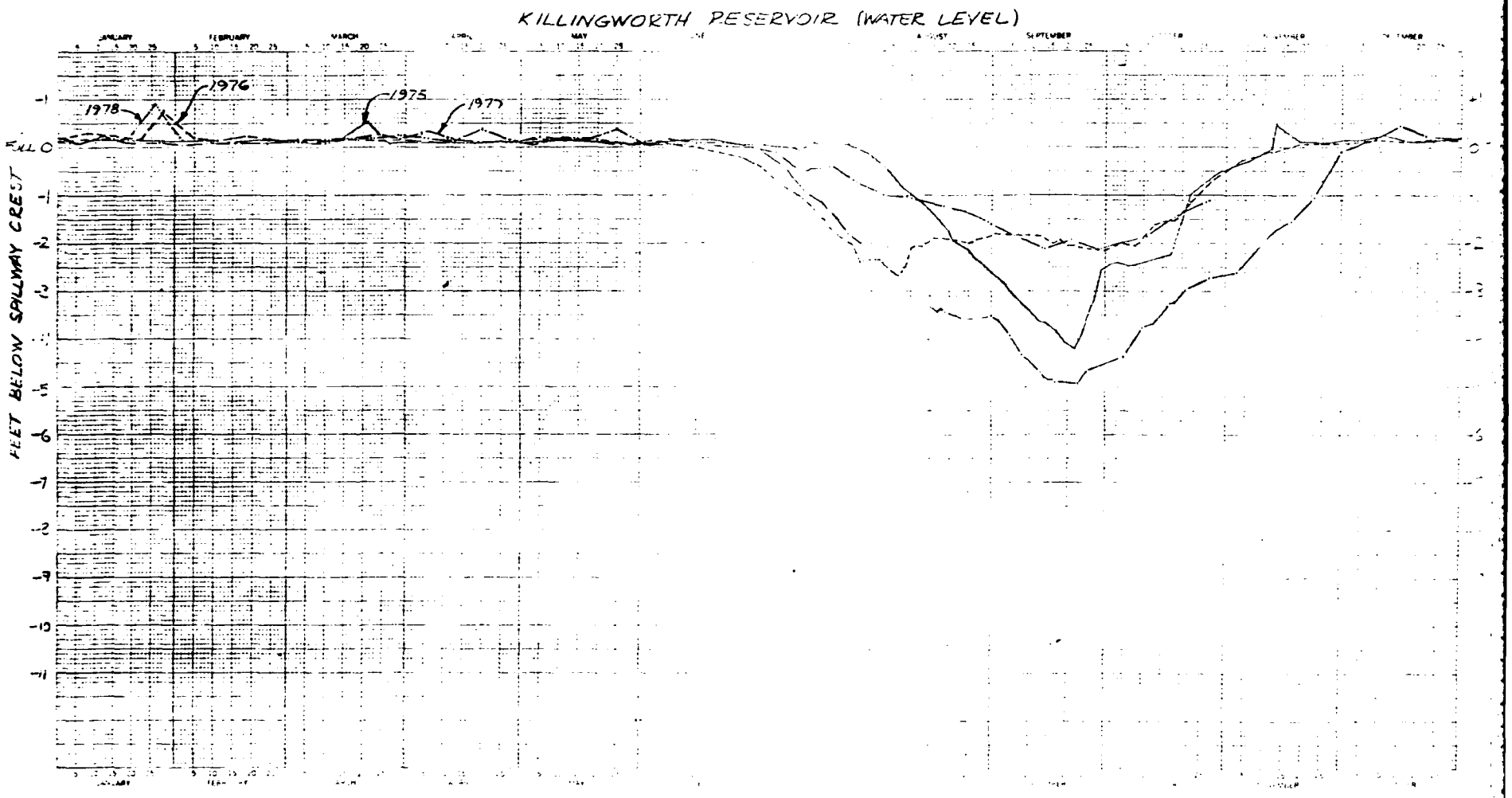
15.) Get from these local agencies, reports on actual or potential road or bridge washouts and be prepared to shut down sections of mains that are affected. Valve boxes should be located well in advance and checked to see that rod will operate the valve.

16.) If any dam shows signs of failing, be prepared to notify downstream residents that may be affected. The Engineering Department will prepare a map showing potential flood areas in case a dam fails. Although the primary method of damage control shall be proper design, construction and maintenance of all dams, failure must be considered a possibility because of changing runoff patterns and unpredictable extremely heavy rainfall such as during a hurricane.

17.) After the flooding, restore each station and source to normal service as soon as practical. Expect high water usage from people cleaning up damage such as hosing down flooded basements, etc. Dry out electrical facilities and where necessary, get Engineering or electrical contractor to doublecheck facilities before running.


CHESTER
DEEP RIVER
COCKAPONSET STATE FOREST
Killingworth Reservoir
Tower Hill
Tower Hill Lake
Roadside Park
Sandpit
Chester Airport
Union Cem.
Star Lake
B-24


KILLINGSWORTH RESERVOIR (WATER LEVEL)
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1974
1973
+1
0
-1
-2
-3
-4
5
-6
-7
-8
-9
-10
-11
5 10 15 20 25


KILLINGWORTH RESERVOIR (WATER LEVEL)
JANUARY
FEBRUARY
MARCH
APRIL
MAY
AUGUST
SEPTEMBER
1978
1976
1975
1977
FULL
FEET BELOW SPILLWAY CREST
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11

B-26

Hillsborough

Full		222	6'		55
	2"	214		2	52
	4"	206		4	50
	6"	199		6	48
	8	192		8	46
	10	185		10	44
1'		178	7		42
	2	172			
	4	166			
	6	160			
	8	154			
	10	148			
2'		142			
	2	137			
	4	132			
	6	127			
	8	122			
	10	117			
3'		112			
	2	108			
	4	104			
	6	101			
	8	97			
	10	93			
4'		90			
	2	86			
	4	83			
	6	80			
	8	76			
	10	73			
5'		70			
	2	67			
	4	65			
	6	62			
	8	60			
	10	57			
6'		-			

deduct 2 MG
not available

B-27

VISUAL INSPECTION CHECKLIST FOR DAMS

The Connecticut Water Company

Dam Name: [illegible]   Inspection Date: [illegible]

Present at Inspection: V. Roberts, [illegible]

Reservoir Level: Down 2"

General condition of slopes or dam faces: EXCELLANT

Any evidence of erosion on upstream face? NO

On downstream face? NO

Any unwanted tree growth? YES - SEE BELOW

Any animal burrows in slopes? NO

Any notable earth movements? NO

Any spongy spots or noticeable seepage? SEEPAGE UNDERDRAIN PIPE AND ACROSS LENGTH OF REVET MATTRESS 50' FROM END OF SPILLWAY SPLASH PAD

Spillway condition: EXCELLANT.

Spillway Obstructions: NONE

Tail Race Conditions: EXCELLANT

Downstream obstructions or undermining of spillway or splash pad: NONE

Comments or recommendations:

→ ① 4 large pines at west end and 4 small ones at east end

Prepared by: [illegible signature] date [illegible]

Reviewed by: date

APPENDIX

SECTION C: DETAIL PHOTOGRAPHS

PHOTO 1 - Downstream face of spillway. Note gabions on sides and bottom of channnel.

PHOTO 2 - Close-up of gabions and erosion behind them.

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	KILLINGWORTH RESERVOIR DAM TR. MENUNKETESUCK RIVER KILLINGWORTH, CONNECTICUT
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	CE# 27 595 DATE Mar. 79 PAGE C-1

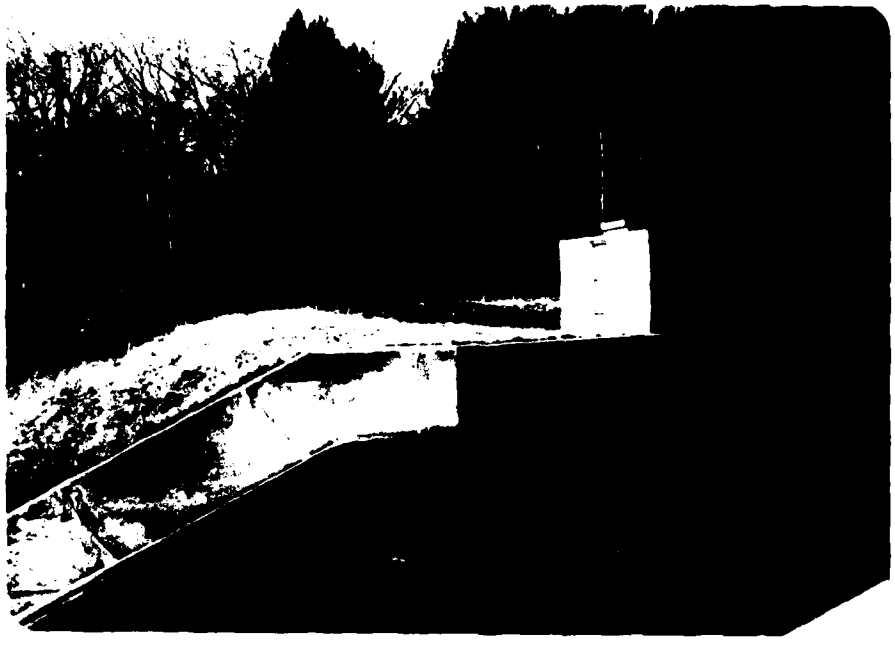


PHOTO 3 - Intake structure and right spillway wingwall. Note cracks which have been sealed.

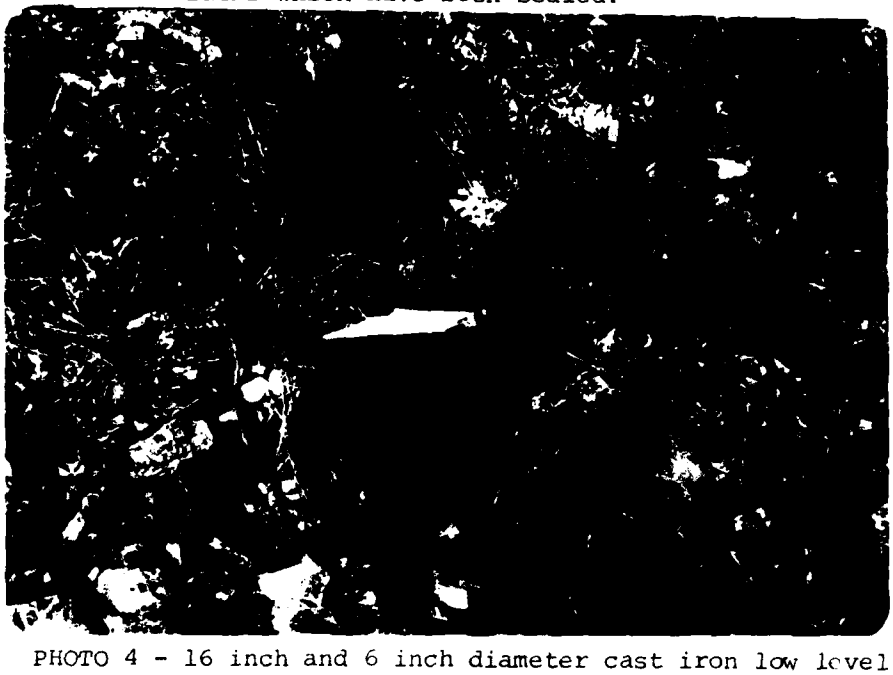


PHOTO 4 - 16 inch and 6 inch diameter cast iron low level outlet pipes from intake structure. 16 inch blowoff pipe not shown.

PHOTO 5 - Downstream face of dam with toe drain.

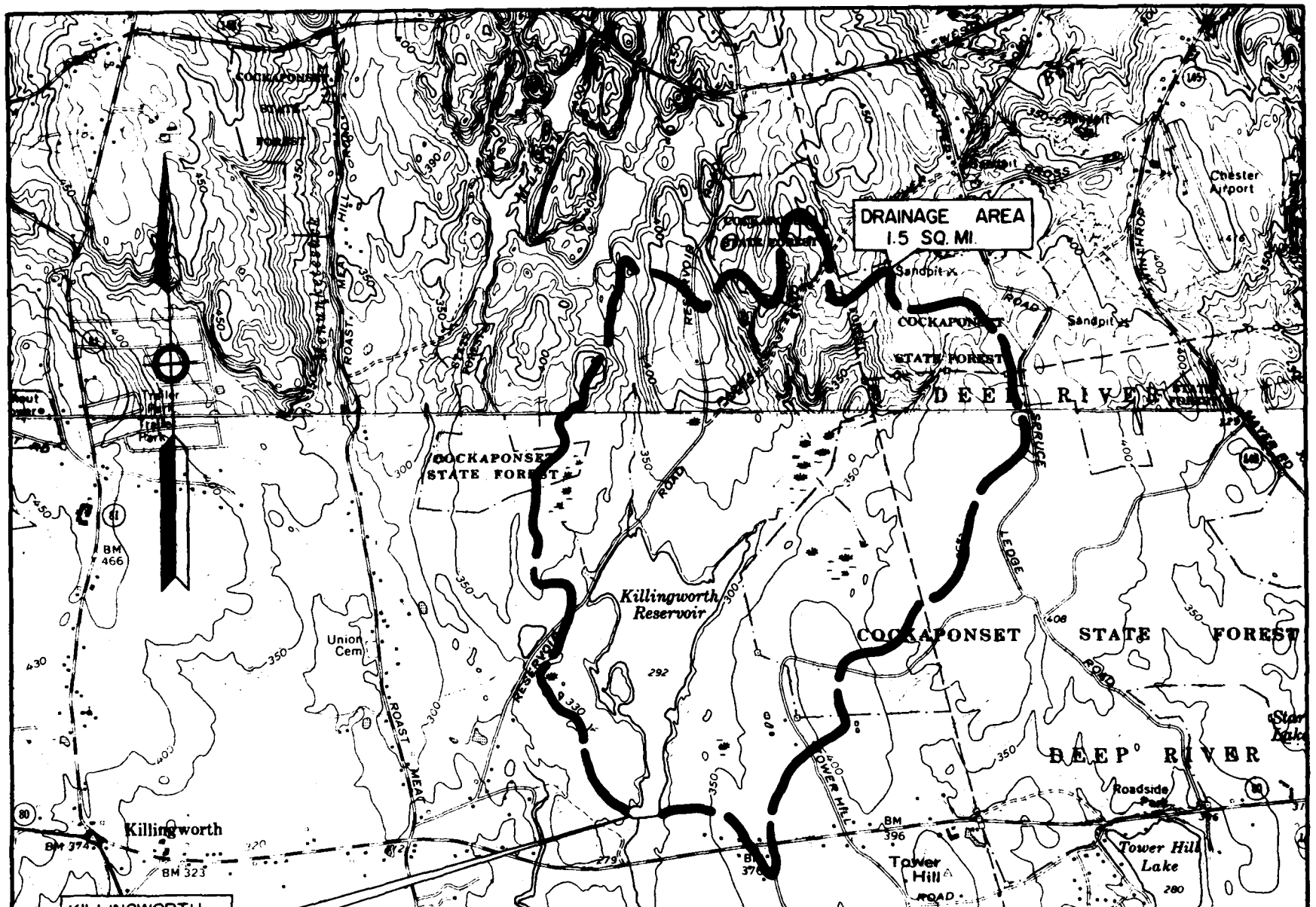
PHOTO 6 - Toe drain outlet pipe in spillway channel gabion wall.

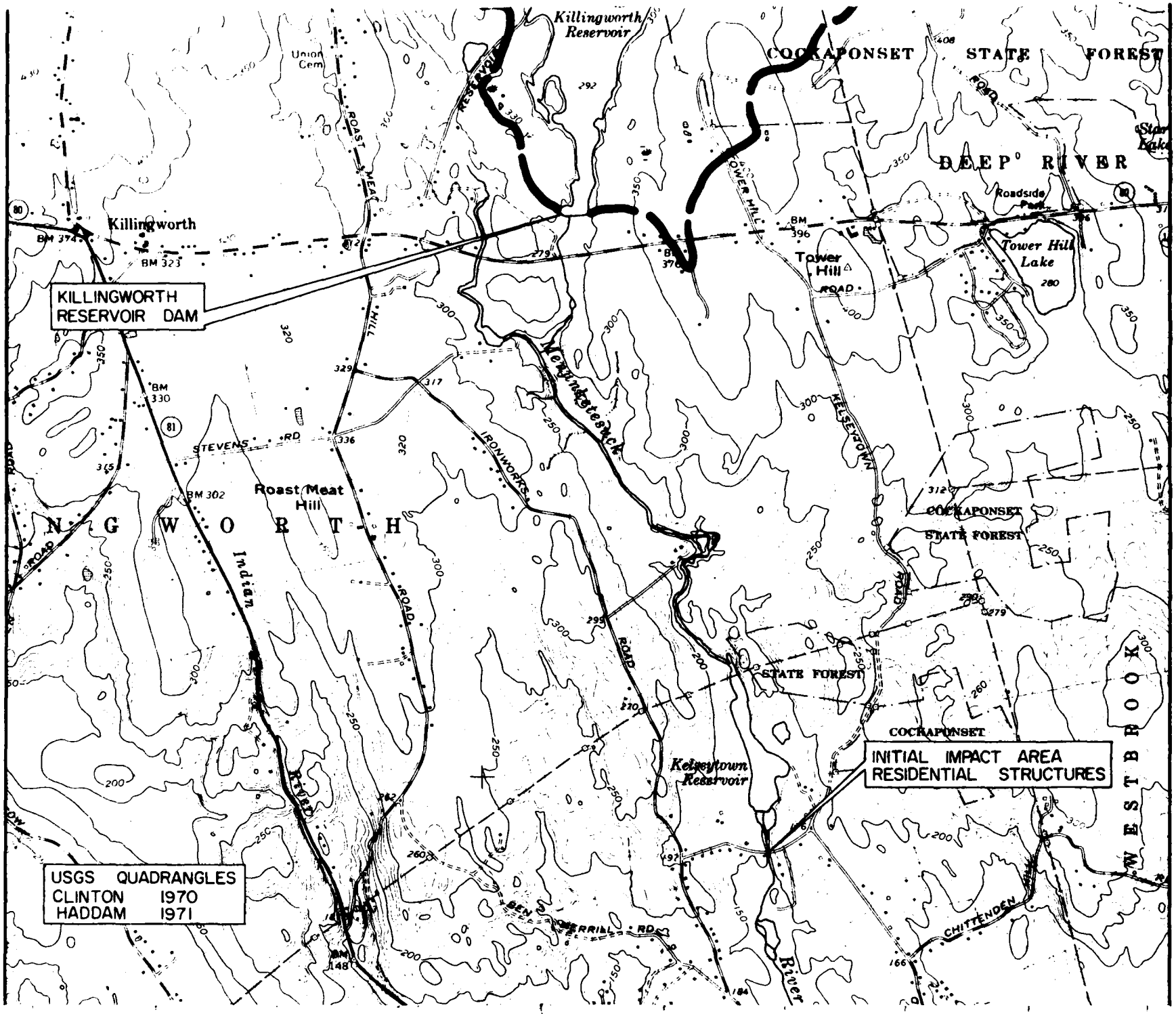
PHOTO 7 - View of crest and upstream face of dam embankment.

PHOTO 8 - Close-up of seep at left downstream toe of dam.

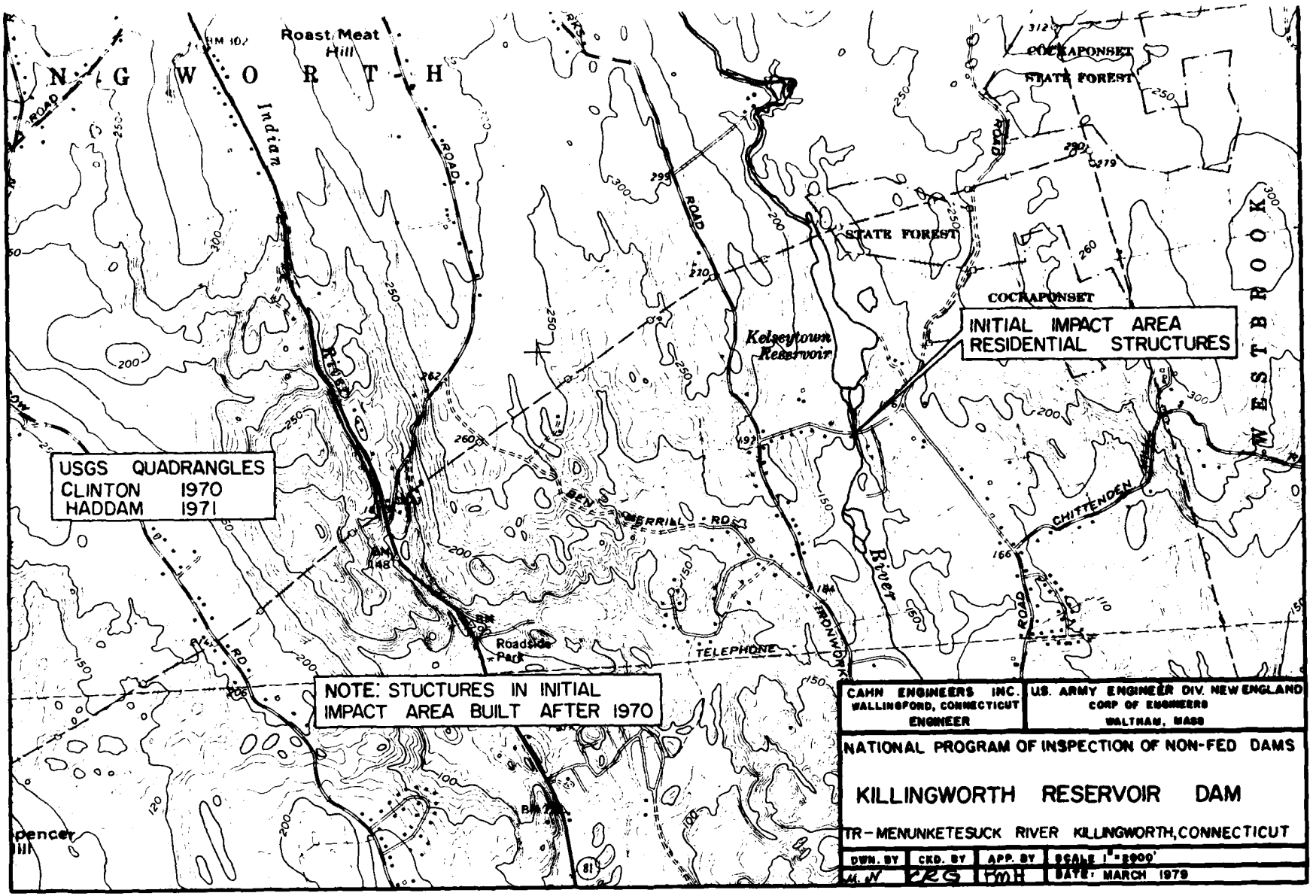
APPENDIX

SECTION D: HYDRAULIC/HYDROLOGIC COMPUTATIONS


DRAINAGE AREA
1.5 SQ. MI.
COCKAPONSET STATE FOREST
DEEP RIVER
Killingworth Reservoir
Killingworth
Tower Hill
Tower Hill Lake
Chester Airport
Roadside
Union Cem.
BM 466
BM 323
BM 396
ROAST MEAT HILL ROAD
SERVICE LEDGE ROAD
TOWER HILL ROAD
RESERVOIR ROAD
WATER RD
Sandpit
Sandpit


KILLINGWORTH RESERVOIR DAM
INITIAL IMPACT AREA RESIDENTIAL STRUCTURES
USGS QUADRANGLES
CLINTON 1970
HADDAM 1971
Killingworth Reservoir
COCKAPONSET STATE FOREST
DEEP RIVER
Killingworth
Tower Hill
Tower Hill Lake
Roadside Park
Roast Meat Hill
Meynkeseck
Indian River
Kelseytown Reservoir
STATE FOREST
COCKAPONSET
STATE FOREST
WESTBROOK
CHITTENDEN
STEVENS RD
BEN HARRIS RD
KELSEYTOWN ROAD
IRONWORKS ROAD
TOWER HILL ROAD
ROAST MEAT HILL ROAD
BM 374
BM 323
BM 330
BM 302
BM 396
BM 148

2 of 3


N G W O R T H
Roast Meat Hill
Indian
ROAD
River
Kelseytown Reservoir
COCKAPONSET STATE FOREST
COCKAPONSET
STATE FOREST
WEST BROOK
CHITTENDEN
ROAD
TELEPHONE
Roadside Park
USGS QUADRANGLES
CLINTON 1970
HADDAM 1971
INITIAL IMPACT AREA
RESIDENTIAL STRUCTURES
NOTE: STUCTURES IN INITIAL
IMPACT AREA BUILT AFTER 1970
CAHN ENGINEERS INC.
WALLINGFORD, CONNECTICUT
ENGINEER
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORP OF ENGINEERS
WALTHAM, MASS
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
KILLINGWORTH RESERVOIR DAM
TR-MENUNKETESUCK RIVER KILLINGWORTH, CONNECTICUT
DWN. BY M.N
CKD. BY CRS
APP. BY FMH
SCALE 1"=2000'
DATE: MARCH 1979

3 of 3

PRELIMINARY GUIDANCE

FOR ESTIMATING

MAXIMUM PROBABLE DISCHARGES

IN

PHASE I DAM SAFETY

INVESTIGATIONS

New England Division
Corps of Engineers

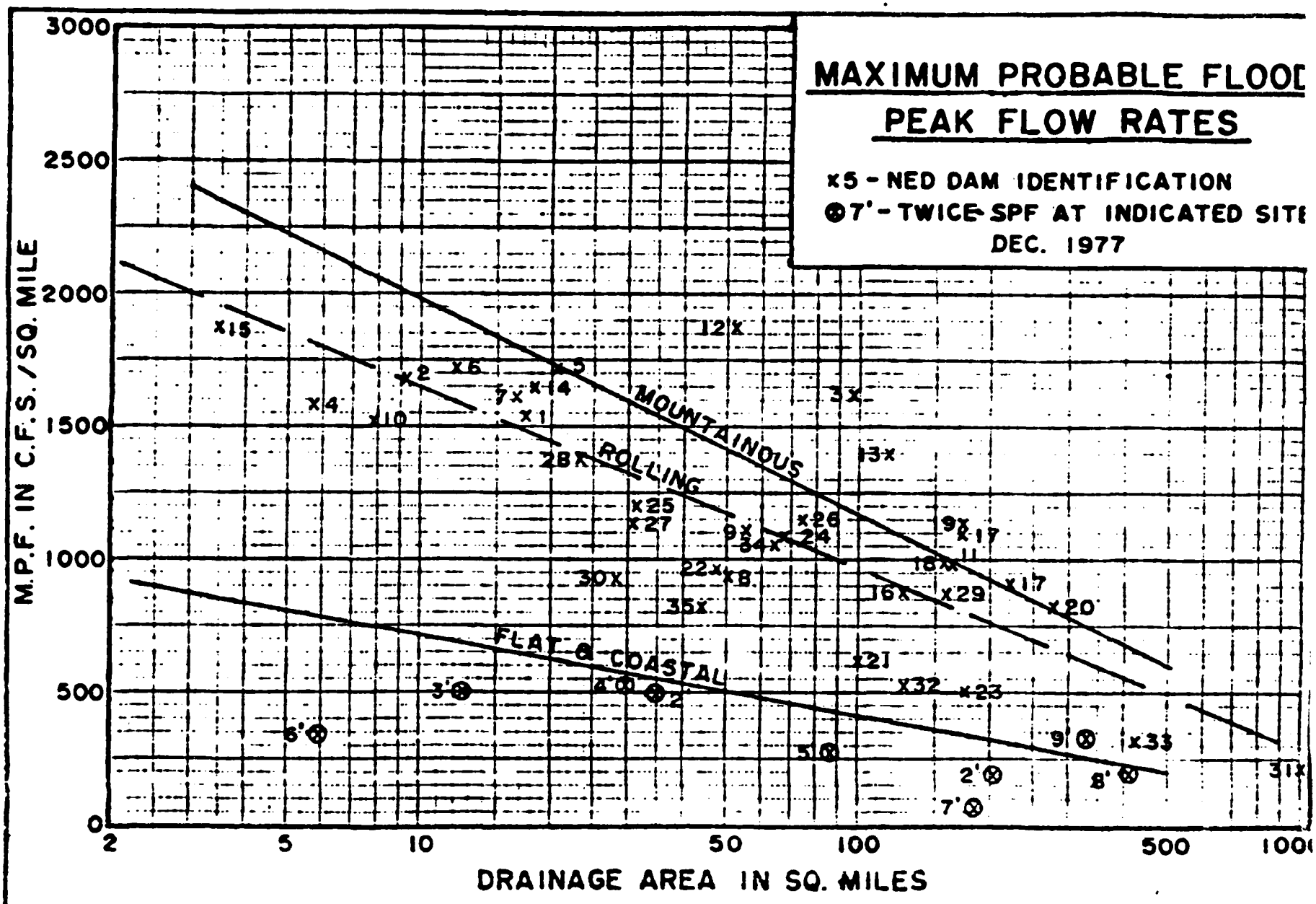
March 1978

MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

	Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1.	Hall Meadow Brook	26,600	17.2	1,546
2.	East Branch	15,500	9.25	1,675
3.	Thomaston	158,000	97.2	1,625
4.	Northfield Brook	9,000	5.7	1,580
5.	Black Rock	35,000	20.4	1,715
6.	Hancock Brook	20,700	12.0	1,725
7.	Hop Brook	26,400	16.4	1,610
8.	Tully	47,000	50.0	940
9.	Barre Falls	61,000	55.0	1,109
10.	Conant Brook	11,900	7.8	1,525
11.	Knightville	160,000	162.0	987
12.	Littleville	98,000	52.3	1,870
13.	Colebrook River	165,000	118.0	1,400
14.	Mad River	30,000	18.2	1,650
15.	Sucker Brook	6,500	3.43	1,895
16.	Union Village	110,000	126.0	873
17.	North Hartland	199,000	220.0	904
18.	North Springfield	157,000	158.0	994
19.	Ball Mountain	190,000	172.0	1,105
20.	Townshend	228,000	106.0(278 total)	820
21.	Surry Mountain	63,000	100.0	630
22.	Otter Brook	45,000	47.0	957
23.	Birch Hill	88,500	175.0	505
24.	East Brimfield	73,900	67.5	1,095
25.	Westville	38,400	99.5(32 net)	1,200
26.	West Thompson	85,000	173.5(74 net)	1,150
27.	Hodges Village	35,600	31.1	1,145
28.	Buffumville	36,500	26.5	1,377
29.	Mansfield Hollow	125,000	159.0	786
30.	West Hill	26,000	28.0	928
31.	Franklin Falls	210,000	1000.0	210
32.	Blackwater	66,500	128.0	520
33.	Hopkinton	135,000	426.0	316
34.	Everett	68,000	64.0	1,062
35.	MacDowell	36,300	44.0	825

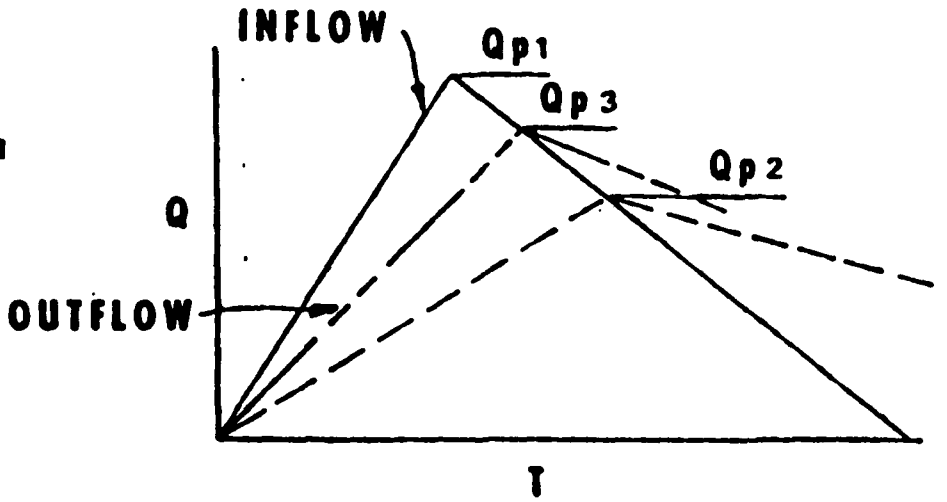
MAXIMUM PROBABLE FLOWS BASED ON TWICE THE STANDARD PROJECT FLOOD (Flat and Coastal Areas)

River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1. Pawtuxet River	19,000	200	190
2. Mill River (R.I.)	8,500	34	500
3. Peters River (R.I.)	3,200	13	490
4. Kettle Brook	8,000	30	530
5. Sudbury River.	11,700	86	270
6. Indian Brook (Hopk.)	1,000	5.9	340
7. Charles River.	6,000	184	65
8. Blackstone River.	43,000	416	200
9. Quinebaug River	55,000	331	330


MAXIMUM PROBABLE FLOOD
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SITE
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
3000
2500
2000
1500
1000
500
0
2
5
10
50
100
500
MOUNTAINOUS
ROLLING
FLAT & COASTAL
x15
x4
x10
x2
x6
x14
x1
12x
3x
13x
28x
x25
x27
x26
x24
9x
34x
22x
x8
30x
35x
x17
x29
x20
x21
x32
x23
x33
31x
3'⊗
4'⊗
2
6'⊗
5⊗
9'⊗
2'⊗
8'⊗
7'⊗

D-4

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Qp_1) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Qp_1".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

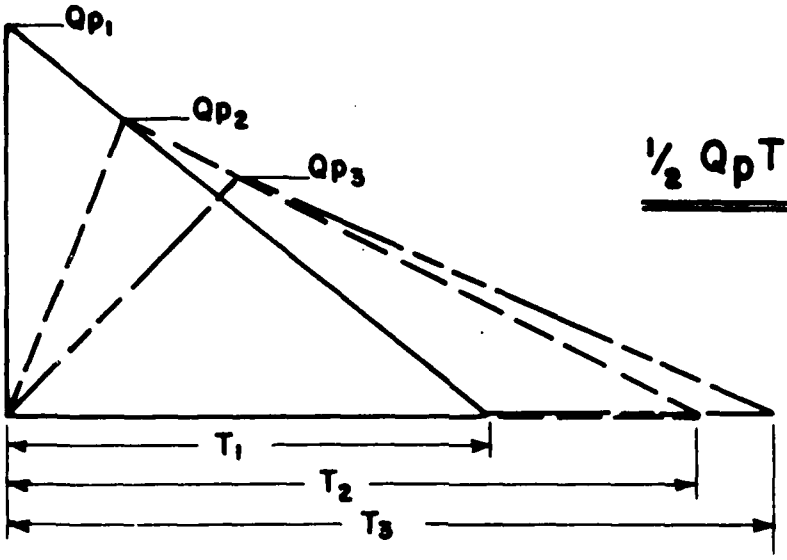
c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore

$$Qp_2 = Qp_1 \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Qp_3".

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Qp_1 = \frac{8}{27} W_b \sqrt{g} Y_o^{\frac{3}{2}}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOMPANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Qp_2(TRIAL) = Qp_1 \left(1 - \frac{V_1}{S}\right)$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Qp_2 = Qp_1 \left(1 - \frac{V_{AVG}}{S}\right)$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

HYDROLOGIC / HYDRAULIC INSPECTION

KILLINGWORTH RESERVOIR DAM, KILLINGWORTH, CT.

I) PERFORMANCE AT TEST FLOOD CONDITIONS:

1) MAXIMUM PROBABLE FLOOD:

a) WATERSHED CLASSIFIED AS "ROLLING"

b) WATERSHED AREA: DA = 1.5 SQ MI

NOTE: CHANDLER & PALMER ENGRS DWG. DATED SEPT. 1938 SHOWS D.A. = 1.5 SQ. MI
U.S.G.S., HARTFORD, CT, D.A. = 1.41 SQ MI; C.E. FROM USGS, HADDAM CLINTON, CT. QUADRANGLES, 1:24000 DA = 1.51 SQ MI)

c) FROM NED-ACE "PRELIMINARY GUIDANCE FOR ESTIMATING MAX. PROBABLE DISCHARGES" - GUIDE CURVE FOR PMF - PEAK FLOW RATES EXTRAPOLATION TO D.A.'S < 2 SQ. MI:

$$PMF \approx 2300 \text{ CFS/SQ MI}$$

d) PEAK INFLOW: $PMF \approx 2300 \times 1.5 \approx 3500$ CFS

2) SPILLWAY DESIGN FLOOD (SDF):

a) CLASSIFICATION OF DAM ACCORDING TO NED-ACE RECOMMENDED GUIDELINES:

i) SIZE*: STORAGE (MAX) $\approx$ 1200 AC-FT ($1000 < S < 50000$ AC-FT)
HEIGHT $\approx$ 29' ($25 < H < 40$ FT)

*STORAGE: FROM U.S. INVENTORY OF DAMS P. 28, DATED 9/15/78; STORAGE AT FLOW LINE: 1084 AC-FT; AT MAX POOL: 1187 AC-FT; C.E. ROUGH CHECK BASED ON LAKE AREA AND GRAPHICAL EXTRAPOLATION OF DATA IN CONN. WATH. CO. OPERATIONS & MAINT. MANUAL STORAGE $\approx$ 1250 AC-FT. HEIGHT: ESTIM. FROM ELEVS. IN AVAIL. DWG. BY. METCALF & EDDY, DATED 7/3/73: "ALTERATIONS TO KILLINGWORTH RESERVOIR" (SEE NOTE P.8)

KILLINGWORTH RESERVOIR DAM

2,a - Cont'd) CLASSIFICATION

iii) HAZARD POTENTIAL: THE DAM IS LOCATED (±) 2 MILES U/S OF KELSEYTOWN RESERVOIR AND (±) 4 MILES U/S OF BUSHY POND. ALTHOUGH THE CHANNEL BETWEEN KILLINGWORTH AND KELSEYTOWN RESERVOIRS IS SPARSELY INHABITED AND PRESENTLY HAS NO STRUCTURES LOWER THAN (±) 15 FT ABOVE THE STREAM BED, STRUCTURES, MOSTLY NEW, ALONG THE CHANNEL D/S FROM KELSEYTOWN RES. TO THE URBAN DEVELOPMENT AT BUSHY POND ARE RELATIVELY LOW AND MORE NUMEROUS. FLOODING OF HOMES DURING HEAVY STORMS IN THIS REACH IS FREQUENT.

iii) CLASSIFICATION:

SIZE: INTERMEDIATE

HAZARD: HIGH

b) SDF = PMF = 3500 CFS ½ PMF = 1750 CFS

3) SURCHARGE AT PEAK INFLOWS:

a) PEAK INFLOW: $Q_{P_1} = 3500$ CFS $Q'_{P_1} = \frac{1}{2}$ PMF = 1750 CFS

b) SPILLWAY (OUTFLOW) RATING CURVE

i) SPILLWAY.

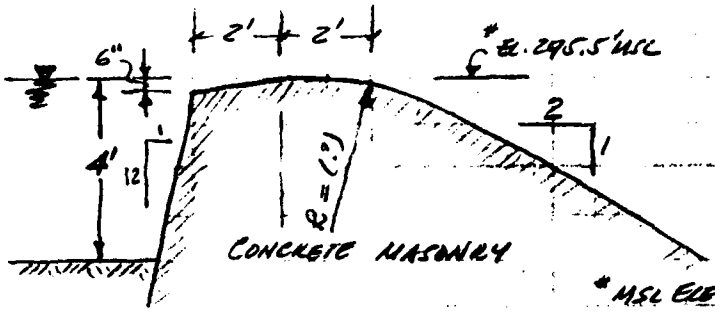
THE SPILLWAY IS CLASSIFIED AS A BROAD CRESTED COMPOUND WEIR OF TRAPEZOIDAL CROSS-SECTION. (SEE SKETCH P. 3). THE U/S FACE ON 4" TO 1" SLOPE FOR A DISTANCE OF 2' FROM THE CREST AND THEN ALMOST VERTICAL WITH A 1" TO 12" BATTER. THE U/S DEPTH OF THE SPILL. IS (±) P = 4'. THE D/S FACE IS ON 2" TO 1" SLOPE

KILLINGWORTH RESERVOIR DAM

3,b - Cont'd) OUTFLOW RATING CURVE

IN PLAN, THE LENGTH OF THE SPILLWAY CREST IS L=40'. THE HEIGHT BETWEEN THE SPILLWAY CREST (EL. 295.5' MSL) AND THE TOP OF THE DAM (EL. 299' MSL) IS H=3.5'.

(DATA FROM CHANDLER & PACHER, ENGRS, NORWICH, CON. DWG. DATED SEPT. 1938; METCALF & EDDY, INC., BOSTON, MASS. DWG DATED 7/3/73 AND C.E FIELD OBSERVATIONS)



* MSL ELEV. BY CONNECTICUT WATER CO. (EL. 296.52' MSL)

∴ SPILLWAY DISCHARGE COEFFICIENT, ASSUME. C= 3.5

USING THE CREST ELEVATION AS DATUM (ELEV. 295.5' MSL), THE SPILLWAY DISCHARGE IS APPROXIMATED BY:

$$Q_s \approx 140 H^{3/2}$$

ii) EXTENSION OF RATING CURVE FOR SURCHARGE HEADS ABOVE TOP OF DAM.

THE DAM IS AN EARTH FILL DAM OF 10' TOP WIDTH; 2"TO 1" U/S FACE SLOPE AND 3"TO 1" D/S FACE SLOPE. THE EMBANKMENT LENGTH, EXCLUDING THE SPILLWAY IS (±) 475' HORIZ. (TOP @ EL. 299' MSL), AND, (±) 45' (TO THE RIGHT) RISING GRADUALLY TO (±) ELEV. 302' MSL. THE TERRAIN TO THE RIGHT OF THE DAM, RISES 12' IN A DISTANCE OF (±) 24'; AND TO THE LEFT OF THE DAM, RISES 12' IN A DISTANCE OF (±) 180'. BOTH SIDES ARE WOODED (DENSE EVERGREEN COVER)

KILLINGWORTH RESERVOIR DAM

3,6-Cont'd.) OUTFLOW RATING CURVE

ASSUME $C = 3.0$ FOR THE EARTH EMBANKMENT AND
$C = 2.0$ FOR THE OVERFLOW AT THE SIDES OF THE DAM (WOODED)

ASSUME, ALSO, EQUIVALENT LENGTHS FOR THE SLOPING PORTION OF THE EMBANKMENT AND THE SIDES OF THE DAM AS FOLLOWS:

$$L'_D = \frac{2}{3}\left(\frac{4.5}{3}\right)(H-3.5) = 10(H-3.5)$$

$$L'_R = \frac{2}{3}\left(\frac{24}{12}\right)(H-6.5) = 1.3(H-6.5)$$

$$L'_L = \frac{2}{3}\left(\frac{180}{12}\right)(H-3.5) = 7.1(H-3.5)$$

THE TOTAL OVERFLOW RATING CURVE CAN BE APPROXIMATED BY:

$$Q_N = 140\,H^{3/2} + 1430(H-3.5)^{3/2} + 44(H-3.5)^{5/2} + 2.6(H-6.5)^{5/2}$$

THE OUTFLOW RATING CURVE IS PLOTTED ON NEXT PAGE

c) SPILLWAY CAPACITY TO TOP OF DAM:

$H = 3.5'$ $\therefore$ $Q_{S_N} = 920$ CFS ((+)26% OF Q_{P_1}; (-)53% OF Q'_{P_1})

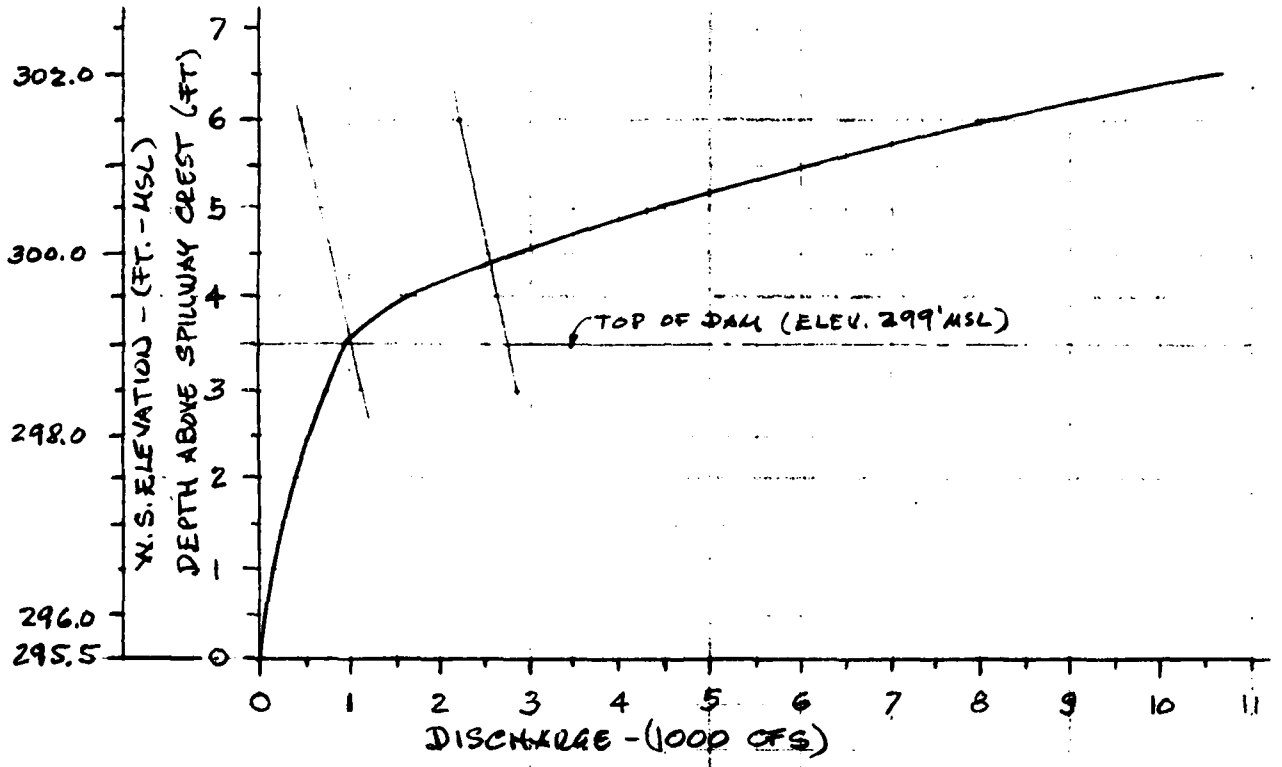
d) SURCHARGE HEIGHT TO PASS Q_{P_1}:

i) @ Q_{P_1} = PMF = 3500 CFS $H_{1_N} = 4.75'$

ii) @ $Q'_{P_1} = \frac{1}{2}$ PMF = 1750 CFS $H'_{1_N} = 4.05'$

KILLINGWORTH RESERVOIR DAM

3 (Cont'd) OUTFLOW RATING CURVE



4) EFFECT OF SURCHARGE STORAGE ON MAX. PROBABLE DISCHARGES (OUTFLOW)

a) RESERVOIR (POND) AREA @ FLOW LINE: $*A_o = 86$ AC.

*FROM CONN. D.E.P. - WATER & RELATED RESOURCES - INVENTORY SHEET (1963)
C.E. CHECK MEASURE (U.S.G.S. 1:24000): A = 85.3 AC. (EL. 292); A = 109 AC. (EL. 300)

∴ ASSUME AVE. LAKE AREA WITHIN EXPECTED SURCHARGE, A = 93 AC.

KILLINGWORTH RESERVOIR DAM

4-Cont'd) EFFECT OF SURCHARGE STORAGE ON PEAK OUTFLOW

b) ASSUME NORMAL POOL LEVEL AT SPILLWAY CREST (ELEV. 295.5' MSL)

c) WATERSHED AREA: D.A. = 1.5 sq mi (see p. 1)

d) DISCHARGE (Q_{P_2}) AT VARIOUS SURCHARGE ELEVATIONS:

$H = 6'$ $V = 93 \times 6 = 558$ AC-FT $\therefore S = \frac{558}{1.5 \times 53.3} = 6.98"$

$H = 3'$ $V = 279$ $\therefore S = 3.49"$

∴ FROM APPROXIMATE STORAGE ROUTING NED-ACE GUIDELINES (19" MAX. PROBABLE P.D. IN NEW ENGLAND)

$Q_{P_2} = Q_{P_1}\left(1 - \frac{S}{19}\right)$ AND FOR ½ PMF: $Q'_{P_2} = Q'_{P_1}\left(1 - \frac{S}{9.5}\right)$

∴ FOR:

$H = 6'$ $Q_{P_2} = 2210$ CFS $Q'_{P_2} = 464$ CFS

$H = 3'$ $Q_{P_2} = 2860$ CFS $Q'_{P_2} = 1110$ CFS

e) PEAK OUTFLOW (Q_{P_3})

USING NED-ACE GUIDELINES "SURCHARGE STORAGE ROUTING" ALTERNATE METHOD (SEE P. 5)

$Q_{P_3} \doteq 2560$ CFS $H_3 \doteq 4.4'$ FOR $Q_{P_1} =$ PMF

$Q'_{P_3} \doteq 980$ CFS $H'_3 \doteq 3.6$ FOR $Q'_{P_1} = \frac{1}{2}$ PMF

KILLINGWORTH RESERVOIR DAM

4-Cont'd) EFFECT OF SURCHARGE STORAGE ON PEAK OUTFLOW

f) SPILLWAY CAPACITY RATIO TO OUTFLOW:

SPILLWAY CAPACITY TO TOP OF DAM: $Q_S \approx 920^{CFS}$

∴ SPILLWAY CAPACITY IS (±) 36% THE OUTFLOW @ PMF AND (±) 94% THE OUTFLOW @ ½ PMF

5) SUMMARY:

a) PEAK INFLOW: $Q_{P_1} = PMF \approx 3500^{CFS}$ $Q'_{P_1} = \frac{1}{2} PMF \approx 1750^{CFS}$

b) PEAK OUTFLOW: $Q_{P_3} \approx 2560^{CFS}$ $Q'_{P_3} \approx 980^{CFS}$

c) SPILLWAY MAX. CAPACITY: $Q_S \approx 920^{CFS}$ OR (±) 36% OF Q_{P_3} AND (±) 94% OF Q'_{P_3}

THEREFORE, AT SDF = PMF, THE DAM IS OVERTOPPED (±) 0.9' (W.S. EL. 299.9' MSL) OR, TO AN AVE. SURCHARGE ABOVE THE SPILLWAY CREST OF (±) 4.4'

AT SDF = ½ PMF, THE DAM IS JUST OVERTOPPED: (±) 0.1' (WS EL. 299.1' MSL) WITH AN AVE. SURCHARGE ABOVE THE SPILLWAY CREST OF (±) 3.6'

KILLINGWORTH RESERVOIR DAM

II) DOWNSTREAM FAILURE HAZARD

1) PEAK FLOOD AND STAGE IMMEDIATELY D/S FROM DAM.

a) BREACH WIDTH:

i) MID-HEIGHT (±) ELEV. 285' MSL ($299 - \frac{29}{2} = 284.5$ SAY 285' MSL)

∴ ii) APPROX MID-HEIGHT LENGTH $\ell = 230'$ (C.E. FROM M.R.E. DRAWING)

∴ iii) BREACH WIDTH (SEE NED-ACE D/S DAM FAILURE GUIDELINES):

$W = 0.4 \times 230 = 92'$ ∴ ASSUME $W_b = 90'$

b) PEAK FAILURE OUTFLOW (Q_p)

ASSUME SURCHARGE TO TOP OF DAM; THEREFORE,

i) HEIGHT AT TIME OF FAILURE: $y_b = 29'$

ii) SPILLWAY DISCHARGE: $Q_s = 920$ CFS

iii) BREACH OUTFLOW (Q_b):

$$Q_b = \frac{8}{27} W_b \sqrt{g}\, y_b^{3/2} = 23600 \text{ CFS}$$

*NOTE: FROM METCALF & EDDY, MASS. DWG "ALTERATIONS TO KILLINGWORTH RESERVOIR" DATED 7/3/73. LOWEST ELEV. OF D/S TOE OF DAM: EL. 270 MSL; TOP OF DAM ELEV. 299' MSL ∴ HEIGHT (MAX) = 29'. CONN. DEP. WATER & RELATED RESOURCES INVENTORY GIVES HEIGHT = 24.5')

KILLINGWORTH RESERVOIR DAM

1,b-Cont'd) PEAK FLOOD AND STAGE IMMEDIATELY D/S FROM DAM

(i) PEAK FAILURE OUTFLOW (Q_{P_1}): $Q_{P_1} = Q_S + Q_D = 920 + 23600 \approx \underline{24500}$ CFS

c) FLOOD WAVE HEIGHT IMMEDIATELY D/S OF DAM:

$Y \approx 0.44\,Y_0 \approx \underline{13'}$

2) ESTIMATE OF D/S DAM FAILURE CONDITIONS AT IMPACT AREA.

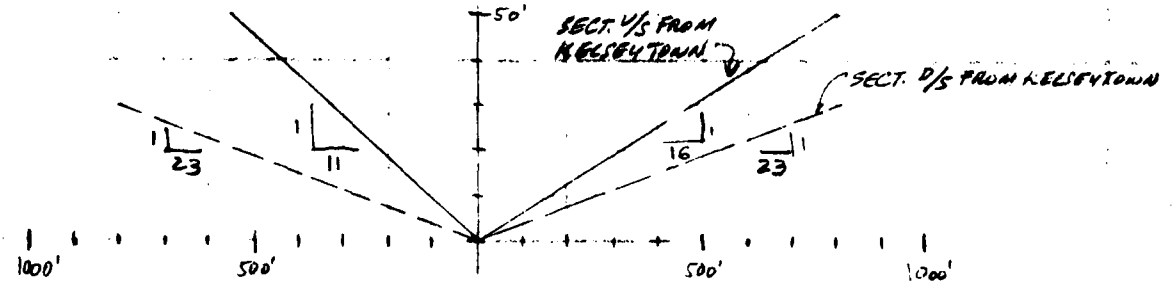
(SEE NED-ACE GUIDELINES FOR ESTIMATING D/S DAM FAILURE HYDROGRAPHS)

ASSUME RESERVOIR FULL TO TOP OF DAM AT TIME OF FAILURE.

a) RESERVOIR STORAGE AT TIME OF FAILURE: $S = 1200$ AC-FT (See p.1)
$S/2 \approx 600$ AC-FT

b) TYPICAL D/S CROSS SECTION & RATING CURVES.

(FROM USGS, CLINTON, CT, QUADRANGLE SHEET, PHOTOREV. 1970, SCALE 1:24000)



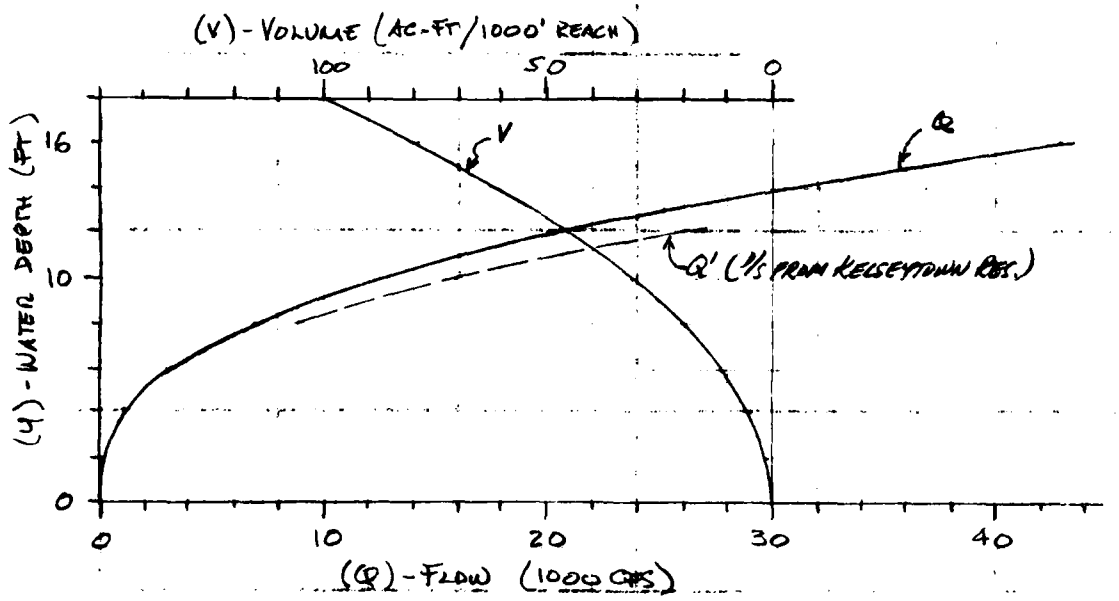
ASSUME: i) $n = 0.050$

ii) SLOPE $S_0 = 1.13\%$ (U/S) (DROPS 105' IN ± 9300); SLOPE $S_0' = 0.638\%$ (D/S KELSEYTOWN) (DROPS ± 30' IN 4700')

KILLINGWORTH RESERVOIR DAM

2-Cont'd) 1/5 DAM FAILURE CONDITIONS AT IMPACT AREA

c) RATING CURVES (1/5 CROSS SECTION)



d) REACH OUTFLOW (Q_{P_3})

i) ASSUME REACH LENGTH $L = 9300'$ (KILLINGWORTH TO KELSEYTOWN RES.)

ii) @ $Q_{P_1} = 24500^{CFS}$ $\therefore Y_1 \approx 12.9'$

$\therefore V_1 \approx 480^{AC-FT} < \frac{S}{2}$ ok $(\frac{S}{2} \approx 600^{AC-FT})$

iii) $Q_{P_2} = Q_{P_1}\left(1 - \frac{V_1}{S}\right) \approx 14700^{CFS}$ $\therefore Y_2 \approx 10.6'$ $V_2 \approx 330^{AC-FT}$

iv) AVE VOLUME IN REACH: $V_{AVE} \approx 405^{AC-FT}$

v) $Q_{P_3} \approx 16200^{CFS}$ $Y_3 \approx 11.0'$ (INFLOW TO KELSEYTOWN RESERVOIR)

D-11a

KILLINGWORTH RESERVOIR DAM

2-Cont'd) D/S DAM FAILURE CONDITIONS AT IMPACT AREA

e) EFFECT OF KELSEYTOWN RESERVOIR ON D/S REACH OUTFLOW (Q_{P_3})

i) INFLOW) FLOOD TO RESERVOIR $Q'_{P_1} = Q_{P_3} = 16200$ CFS

ii) GENERAL DATA ON KELSEYTOWN RESERVOIR (FROM CONN. WATER CO.):

LENGTH OF SPILLWAY: $L = 194'$ (CONSTITUTES MOST OF THE DAM)
HEIGHT TO TOP OF DAM: $H = 25'$
DATA ON AN EXISTING AUXILIARY SPILLWAY NOT KNOWN (ASSUME ±100'. SAME ELEV.
AREA AT FLOWLINE: $A_N = 18$ ACR. (C.E. FROM U.S.G.S. 1:24000)
TERRAIN AT THE SIDES OF THE DAM RISES: ± 45' IN A TOTAL (L+R)
OF (±) 700'

∴ ASSUME: $C = 3.5$ FOR THE SPILLWAYS
$C = 2.5$ FOR THE SIDE SPILLS

EQUIVALENT SIDE SPILLS LENGTH: $L'_N = \frac{2}{3}\left(\frac{700}{45}\right)(H-2.5) = 31\,(H-2.5)$

∴ THE KELSEYTOWN RESERVOIR OUTFLOW CAN BE APPROX. BY:

$$Q_N = 1030\,H^{3/2} + 80\,(H-2.5)^{5/2}$$

f) KELSEYTOWN RESERVOIR OUTFLOW

i) $Q'_{P_1} = 16200$ CFS SURCHARGE TO PASS Q'_{P_1}: $H'_1 = 5.8'$

ii) $V_R = 104$ AC FT ; $Q'_{P_2} = 16200\left(1 - \frac{104}{1200}\right) = 14800$ CFS

iii) @ $Q'_{P_2} = 14800$ CFS $H'_2 = 5.6'$ $V_R = 100$ AC FT $V_{SURF} = 102$ AC FT

KILLINGWORTH RESERVOIR DAM

2,f-Cont'd) KELSEYTOWN RESERVOIR OUTFLOW

iii) RESERVOIR OUTFLOW: $Q'_{P_3} \approx 14800$ CFS $H'_3 \approx 5.6'$ ABOVE SPWY.

g) EFFECT OF KILLINGWORTH RES. DAM FAILURE D/S FROM KELSEYTOWN RESERVOIR -

THE IMPACT AREA IS JUST D/S FROM KELSEYTOWN. TYPICAL CHANNEL CROSS-SECTION IS SHOWN ON P. 9 AND CHANNEL RATING CURVE ABOUT $Q = 15000$ CFS IS SHOWN ON P. 10 (DASHED LINES)

i) FAILURE FLOOD AT FIRST IMPACT AREA: $Q''_{P_3} \approx 14800$ CFS

ii) ESTIMATED WATER DEPTH: $Y''_3 \approx 9.7'$

3) SUMMARY

a) PEAK FAILURE OUTFLOW: $Q_P = 24500$ CFS STAGE $Y_1 \approx 13'$

b) REACH OUTFLOW (D/S OF KELSEYTOWN RES.): $Q_{P_3} \approx 16200$ CFS
STAGE: $Y_3 \approx 11.0'$

c) KELSEYTOWN RES. OUTFLOW: $Q'_{P_3} \approx 14800$ CFS
SURCHARGE AT KELS. RES $H_3 \approx 5.6'$ ABOVE SPWY ($\approx 3.1'$ OVERTOPPING)

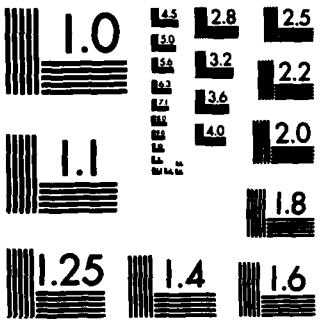
d) KILLINGWORTH RES. DAM FAILURE FLOOD @ FIRST IMPACT AREA: $Q''_{P_3} \approx 14800$ CFS
STAGE: $Y''_3 \approx 9.7'$

APPENDIX

SECTION E: INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

AD-A144 668 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS KILLINGWORTH RESERVOI..(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAR 79 2/2

UNCLASSIFIED F/G 13/13 NL



INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST	STATE	COUNTY	CONGR DIST	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
CT	[illegible]	[illegible]	CT	017	03				KILLINGWORTH RESERVOIR DA	4121.5	7232.1	09	MAR	79

POPULAR NAME	NAME OF IMPOUNDMENT
	KILLINGWORTH RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI)	POPULATION
[illegible]	7	TRIBUTARY TO SIDE RIVER	KELSEYTOWN	4	2500

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	STATUS	OWN	FED R	PHY/FED	SCS A	VER/DATE
[illegible]	1895	S	29	29	1200	1080	MOD	N	N	N	N	09MAR79

REMARKS
RECONSTRUCTED 1938, ALTERATIONS 1973

D/S DAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	500	C	40	920												

OWNER	ENGINEERING BY	CONSTRUCTION BY
CONNECTICUT WATER CO	CHANDLER & PALMER	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
CT WATER RESOURCES	CT WATER RESOURCES	CT WATER RESOURCES	CT WATER RESOURCES

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
CORPS ENGINEERS INC	19	DEC	78	PL92-367

REMARKS
37-FOR 1938 RECONSTRUCTION

END

FILMED

DTIC